Comprehensive Long-Term Environmental Action Navy (CLEAN)

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HUNTERS POINT ANNEX
HUNTERS POINT, CALIFORNIA

PHASE 1B ECOLOGICAL RISK ASSESSMENT

RESPONSE TO AGENCY COMMENTS
WORK PLAN
FIELD SAMPLING PLAN
QUALITY ASSURANCE PLAN

Department of the Navy
Western Division
Naval Facilities Engineering Command
San Bruno, California 94066-2402

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN I)
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DEPARTMENT OF THE NAVY
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PHASE 1B ECOLOGICAL RISK ASSESSMENT RESPONSE TO AGENCY COMMENTS ON THE DRAFT FINAL WORK PLAN, DRAFT FINAL FIELD SAMPLING PLAN, AND DRAFT QUALITY ASSURANCE PROJECT PLAN HUNTERS POINT ANNEX

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1.0 INTRODUCTION

This document presents the Navy's responses to comments from the regulatory agencies on the Hunters Point Annex phase 1B ecological risk assessment draft final work plan (PRC 1995a), draft final field sampling plan (PRC 1995b), and draft quality assurance project plan (QAPP) (PRC 1995c). Responses were received from the California Department of Health Services (DHS); the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB); the California Department of Toxic Substances Control (DTSC); the DTSC Office of Scientific Affairs (OSA); the U.S. Environmental Protection Agency (EPA); the EPA Quality Assurance Management Section; and the California Department of Fish and Game (CDFG). The next section presents the response to comments on the work plan and field sampling plan and the last section presents the response to comments to the QAPP. Each section is divided into subsections organized by agency comments.

2.0 RESPONSE TO COMMENTS ON THE PHASE 1B ECOLOGICAL RISK ASSESSMENT WORK PLAN AND FIELD SAMPLING PLAN

The following sections present the responses to comments on the phase 1B ecological risk assessment work plan (PRC 1995a) and the field sampling plan (PRC 1995b).

2.1 DHS COMMENTS

1. **Comment:** **Thank you for the opportunity to review the Field Sampling Plan for the Phase 1B Ecological Risk Assessment for Hunters Point Annex (HPA). As you know, we are concerned that off-site contamination from the HPA site may be affecting fish and these fish may pose a health risk to persons consuming fish in areas near the site.**

   Recent data from the Regional Water Quality Control Board's pilot study of fish contamination (*Contaminant Levels in Fish Tissue from San Francisco Bay*, June 1995) presents additional evidence that some contaminants of concern at HPA, such as polychlorinated biphenyls (PCBs), are elevated in fish collected near the site. Samples taken near HPA had the highest level of PCBs in one species of fish, surfperch, among 8 sites and the 3rd highest level for white croaker, among 9 sites. Keep in mind that comparison sites included the most contaminated areas of the Bay.

   The tissue residue sampling described in the field sampling plan focuses on collection of invertebrates, not fish. The sampling plan states that

demersal fish will be collected if available. However, because of the sampling methods used (grab sampler and sediment dredge), collection of any fish samples appears unlikely. We recommend that greater effort be made to obtain fish samples in the field sampling plan. For example, sampling methods specifically for collection of fish samples, such as the use of otter trawls, should be employed.

Response: The Navy believes that the study by the RWQCB adequately answers the questions on the uptake of contaminants by fish in San Francisco Bay. The two fish (surfperch and croaker) that DHS proposes for collection are the same as those collected by the RWQCB. Although the surfperch and croaker are more localized than the other fish used in the study by RWQCB, the two species are not so localized as to remain primarily in the HPA offshore area. Therefore, these fish do not represent contaminant uptake from HPA alone. The fish may or may not have been exposed to contaminants in the offshore area around HPA. The benthic invertebrates to be sampled for the ecological risk assessment at HPA are less mobile than fishes and more representative of conditions at HPA.

2. **Comment:** **In addition to obtaining fish samples during the planned field sampling, we also recommend that the field sampling plan include analysis of fish samples already collected during Phase 1A. Your report on demersal fish sampling noted that the most common species collected would be stored for one year. We suggest that you analyze the stored surfperch samples if still available.**

Response: The current holding time recommended for fish tissue analysis is 6 months after extraction and it has been almost 2 years since these samples were collected and analyzed (November 1993). Due to the holding time, the laboratory archived samples for 1 year and then disposed of them.

3. **Comment:** **We understand that the field sampling plan focuses on ecological risks, not human health risks. However, there does not appear to be any off-site field sampling planned for the human health risk assessment. We hope that you will consider obtaining fish samples during the field sampling plan for the ecological risk assessment. This information will shed light on both ecological and human health risks from the site.**

Response: As noted above in the response to DHS comment 1, the ecological risk assessment is focused on species expected to have the greatest exposure to contaminated sediments at HPA. These species, invertebrates primarily, are not consumed by humans and will be used for food-web modeling. The RWQCB has already determined that consuming fish caught in the bay may pose a human health threat. It is not clear from the comment what additional information would be gained by sampling fish offshore of HPA that are exposed to bay-wide contamination.

The HPA shoreline around Parcels B, D, and E have been posted with warning signs that advise against eating fish or shellfish. In addition all piers

will be posted with warning signs.

2.2 RWQCB COMMENTS

1. **Comment:** **The RWQCB requests that the Navy use NOAA's ER-Ls/ER-Ms (Long and MacDonald 1995) instead of the wetland creation values (RWQCB, Wolfenden and Carlin, 1992) as screening values for sediments at Hunter's Point. It is inappropriate to use the wetlands screening criteria document because it was not developed for screening subtidal sediments and it used the earlier NOAA ER-Ls, which have since been revised, to derive the wetland creation values. The earlier NOAA ER-Ls were derived from both marine and freshwater data, and therefore are not relevant to San Francisco Bay. Comparison of Hunter's Point site data to the means from the SF Bay Regional Monitoring program is acceptable.**

   Response: Currently, the Navy and the regulatory agencies are working together to develop sediment screening criteria specific to San Francisco Bay using the RWQCB data set. Once these screening criteria have been agreed upon, they will be used in the HPA ecological risk assessment.

2. **Comment:** **Two additional sampling points were chosen to evaluate potential impacts from areas where high levels of metals were found. These sampling points are designated S1 and S2 in *Figure 6-4 Sediment Sample Locations Offshore of Parcel E.* The legend indicates that surficial samples will be taken at these two locations. A depth profile of chemistry should accompany toxicity testing at these locations. Board staff recommend that three foot cores be taken and evaluated for bulk chemistry on one foot sampling intervals.**

   Response: Sediment samples will be taken to a depth of 3 feet and analyzed in 1-foot increments at sampling points S1 and S2..

3. **Comment:** **As per our November 14, 1994 [sic] comments on the Phase 1B work plan (specific comment #3) the sediment value for copper should be 851 ppm instead of 20.8 ppm. Figure 3-2, Appendix A - ESAP, chemical data tables and subsequent hazard quotients should be modified to reflect this change.**

   Response: The value will be changed. The corrected hazard quotient using the effects range-low (ER-L) value as the denominator is now 25.01, and the corrected hazard index for the ER-L values is 7906.51. The corrected hazard quotient using the effects range-median (ER-M) value as the denominator is now 3.15, and the corrected hazard index for the ER-M values is 28.06. Table 3-6, Figure 3-2, Figure 3-7, and Appendix A have been revised to reflect this correction.

2.3 DTSC COMMENTS

1. **Comment:** **The Department of Toxic Substances Control, (Department) recommends that due to the dredging project by Department of Parks and Recreation on Parcel F, the ecological field work commences according to plans. Any deviation to the schedule should be brought to our attention for further evaluation.**

Response: The Navy plans to be in the field by October 23, 1995, and the Navy will contact DTSC if any schedule changes are anticipated.

2. **Comment:** **Further, despite assurances from the Navy, the State has yet to receive response to our previous comments from the Regional Water Board for your consideration.**

Response: The Navy's responses to the comments on the draft work plan was sent to DTSC on September 1, 1995.

3. **Comment:** **Section 1.1, the Department disagrees with the decision that the ecological investigation will be done in "three phases". The investigation to assess any risk to the environment or human health can be done in many phases and can take on many distinct scopes of work. It is thus premature to decide and concur with the three-phase scope. In our previous comment letter to the Navy, the Department expressed that additional sampling may be required, as appropriate, for further characterization as well as developing and evaluating remedial options.**

Response: It is logical to assume that the ecological risk assessment may be accomplished using a three-phase approach. It is agreed that additional phases may be required, but the Navy intends to move forward with the existing plans for accelerated cleanup under the Superfund Accelerated Cleanup Model (SACM), using a presumptive remedy approach to cleanup of contaminated sediments.

4. **Comment:** **Section 6.1, please explain why contaminants in the groundwater will not flow with groundwater into the bay. This implies that groundwater contamination flows in a different direction, hence no discharges into the bay. However, the author did not expound on the likelihood of water soluble chemicals that will flow into the bay, as paragraph one indicates. We disagree with the implications of the statement. The Navy needs to explain further.**

Response: Soluble contaminants are expected to flow with groundwater, but the rate of flow to the bay is not known at this time. Groundwater will be further analyzed in the final report.

5a. **Comment:** **Section 6.3, please explain how preliminary assessment of offshore areas will dovetail in to the present sampling event scheduled for fall of 1995. It is understood that results of such studies will be submitted to agencies**

for evaluation.

Response: If hot spots are discovered during the preliminary assessment of Parcel F, the Navy will attempt to incorporate them into the present sampling plan. If hot spots are discovered after the planned sampling event, then the Navy will formulate a sampling plan to address them. The sampling plan and the results of the preliminary assessment will be sent to the agencies for review.

5b. **Comment:** **Further, please explain the significance of a reference point recommended by the Regional Board. It is not clear how that information will assist the Navy in conducting the ecological investigation.**

Response: Sediments from the proposed reference stations will be collected and used in the bioassay tests. The results of the bioassays using HPA sediments will then be compared with the bioassay results from the reference sites. This information will provide a means to evaluate the toxicity of HPA sediments in relation to relatively uncontaminated sites in San Francisco Bay.

6. **Comment:** **As we indicated in our previous comment letter, the Navy agreed that "bathymetric studies", which was requested by the Regional Water Board in their comment letter, will be done and results incorporated in the Sampling Plan. However, the Department could not find the results of such studies in the Sampling Plan. It is not clear when such studies will take place. The Navy has acknowledged that the result of "bathymetric studies" could change the transect locations. The State would like to receive the results of such a study before changing the transect locations.**

Response: The Navy did not agree to conduct a bathymetric study. The Navy has positioned its sampling scheme according to the depth profiles around HPA presented in the sediment study in San Francisco Bay performed by the U.S. Army Corps of Engineers (USACE 1992). The Navy will also review available dredging records to assure that sample locations are correct.

2.4 OSA COMMENTS

GENERAL COMMENTS

1. **Comments:** **This version of the work plan reflects the response to agency comments and reflects additional discussions among the parties. There are several points which should be clarified, but response to the comments listed below can take the form of a separate memorandum, which can be attached to the work plan as an addendum, so that the entire work plan need not be revised. The most critical technical issue is the level of correlation which shall be considered 'acceptable' to be predictive of toxicological response.**

Response: All documents will be submitted in one binder which will include the response to comments for the work plan, FSP, and QAPP. The field sampling plan and QAPP will also be revised to reflect the changes (which will be redlined).

Specific concerns about the level of correlation are addressed below in response to DTSC OSA specific comment 2. The negotiated level of correlation should be established for all toxicity tests.

SPECIFIC COMMENTS

1. **Comment:** **How will assessment of the grain size and pH data allow evaluation of the accuracy of the resultant bioavailable fractions (Section 6.4.3, page 31).**

Response: Grain size and pH provide a means to check the levels of the bioavailable fraction to determine whether or not they are reasonable. If the bioavailable fractions are low, then the sediments might be expected to contain high levels of coarse grains and the pH might be expected to be high. If the sediment grain size is predominantly in the fines and the pH is low, then high bioavailable concentrations seem reasonable.

2. **Comment:** **As stated in previous memoranda we doubt it will be possible to predict the results of aquatic toxicity tests based on physical or chemical sediment measurements or MICROTOX results with sufficient accuracy. MICROTOX® results are presented as "within one order of magnitude of the EC_{50} values from other bioassays" (Section 7.1.3, page 35) for 85 percent of the data evaluated. If the correlation coefficient is greater than 0.5 the MICROTOX® results will be used to predict the aquatic toxicity result for stations where aquatic bioassays are not performed (Section 8.1, Step 4, page 39). A correlation coefficient (r) of 0.5 indicates that the coefficient of determination [r^2] is 0.25 and that only 25 percent of the variation in the aquatic toxicity test results would be accounted for in the variability of the MICROTOX® results. A correlation coefficient of 0.5 is not an indicator of a sufficiently accurate correlation. Additional discussions should be scheduled to determine what level of correlation is sufficient for participating regulatory agencies.**

Response: The correct correlation coefficient is 0.71, which corresponds to a coefficient of determination of 0.50. This would be interpreted as 50 percent of the variation in the aquatic toxicity test results being attributable to variation in MICROTOX® bioassays.

3. **Comment:** **How will dermal contact be evaluated "qualitatively" (Section 8.2.1, page 40) for avian aquatic receptors? Dermal exposure should be factored into the estimation of dose for those receptors being evaluated using the dose methodology. Dermal contact can be a significant route of exposure and**

might be expected to be significant in a wading shorebird. A similar comment was made on the preliminary draft work plan.

Response: Dermal contact will be evaluated through review of literature addressing exposure of wildlife to contaminants through dermal contact. From the information collected in this review, the proportion of the total exposure of assessment endpoint receptors at HPA contributed by dermal contact will be estimated. Whether dermal exposure must be evaluated in more detail for assessment endpoints at HPA will be based on this qualitative assessment. As a result of recent discussions with representatives of EPA and DTSC, the Navy has become aware of research on dermal exposure through birds' legs. Other recommendations for reference material on dermal exposure are always welcomed and appreciated.

4. **Comment:** **We agree that development of 'high' dose and 'low' dose estimates (Section 8.2.1.4, page 45) coupled with 'high' and 'low' toxicity reference values (TRVs) (Section 8.2.2.2, page 48) will enhance communication of the range of probable ecological risk.**

Response: Comment acknowledged.

5. **Comment:** **We agree that discussion of the exact uncertainty factors to be applied in developing the TRVs can await development of the core toxicological data set (Section 8.2.2.2, page 48).**

Response: Comment acknowledged.

6. **Comment:** **The uncertainty factor column of the TRV data table (Section 8.2.2.2, page 49) should be expanded to allow separate indication of each uncertainty factor applied in development of the TRVs. For example, the uncertainty factor for LOAEL-to-NOAEL acute-to-chronic, cross-species extrapolation and all other uncertainty factors should be indicated separately.**

Response: All transformations performed on raw toxicological data to develop TRVs, including the use of uncertainty factors, will be clearly indicated for each TRV. The Navy is currently working closely with representatives of EPA and DTSC to develop mutually acceptable methods for deriving TRVs.

7. **Comment:** **Please indicate the 'groups' proposed for summing hazard quotients (HQs) will be similar chemistry and toxicological modes of action (Section 8.2.3, page 51).**

Response: The contaminant groups proposed for summing of hazard quotients have not yet been identified. As stated in the work plan, similar chemistry and toxicological modes of action will guide the grouping process. Contaminant groups will be identified based, in part, on discussions with the regulatory agencies when data analysis begins.

8. **Comment:** **The conclusions regarding the ecological risk to terrestrial receptors posed by contaminants in Parcels B, C, D (Section 9.0, page 51) should be formalized in a scoping level assessment of these parcels to complete the administrative record.**

Response: Ecological risk to terrestrial receptors will be addressed in the remedial investigation reports for Parcels B, C, and D.

9. **Comment:** **The assessment of non-bioaccumulative compounds on small mammals should include both the 'high' and 'low' dose estimates. The work plan currently states it 'may' involve both estimates (Section 9.1, page 53). Dermal exposure should be factored into the estimation of dose for those receptors being evaluated using the dose methodology. Dermal contact can be a significant route of exposure and might be expected to be significant in a burrowing rodent.**

Response: The terrestrial screening assessment dose equations presented in section 9.0 of the work plan will be modified to incorporate high and low estimates of dose. High and low estimates for the dose equations presented in section 9.1 (for small mammals) and 9.2 (for the American kestrel) will parallel those in section 8.2.1.4. In general, for the high dose estimate, a high contaminant concentration in soil, a high biomagnification factor when appropriate (taken from literature), a high ingestion rate (taken from literature), and a low body weight (taken from literature) will be used; for the low dose estimate, the mean contaminant concentration in soil, a low biomagnification factor when appropriate (taken from literature), a low ingestion rate (taken from literature), and a high body weight (taken from literature) will be used. Please see the response to EPA specific comment 29 (below) for details on contaminant concentrations to be used in dose estimates. Regarding dermal exposure, please see the response to DTSC OSA specific comment 3 (above). Also, please see the response to DTSC OSA specific comment 10 below.

10. **Comment:** **Will contaminants which are known to bioconcentrate from soil to plant tissues be evaluated in the 'non-bioaccumulative' methodology (Section 9.2, page 53)? The dose equation for the 'non-bioaccumulative' methodology should be modified to separate the soil intake from food intake with a bioconcentration factor included for food intake. This would allow evaluation of dose using contaminant-specific bioconcentration factors for primary consumption.**

Response: The screening assessment dose equations will be the same as the equation presented in section 8.2.1 for aquatic avian assessment endpoints, except that the time for the concentration of the contaminant in prey will be estimated based on field-measured soil or sediment contaminant concentrations and estimates of biomagnification factors. Therefore, the site use factor (SUF) will be added to these screening assessment equations. Estimates of biomagnification factors for soil to plants, soil to invertebrates (such as

earthworms), and soil to small mammals will be used in these dose equations. These factors will be taken (or, if necessary, calculated) from the literature and from data from other approved ecological assessment reports. Exposure duration (ED) will be assumed to be equal to 1, and thus removed from the equation, because the dose is calculated on a daily rather than annual basis.

11. **Comment:** **The assessment of bioaccumulative organic and inorganic compounds on the kestrel should include both the 'high' and 'low' dose estimates. The work plan currently states it 'may' involve both estimates (Section 9.2, page 55). Dermal exposure should be factored into the estimation of dose for those receptors being evaluated using the dose methodology.**

Response: As stated in the response to DTSC OSA specific comment 9, above, the terrestrial screening assessment dose equations presented in sections 9.1 and 9.2 of the work plan will be modified to incorporate high and low estimates of dose. Please see the response to this comment and to EPA specific comment 29 (below) for details. Regarding dermal exposure, please see the response to DTSC OSA specific comment 3, above.

CONCLUSIONS

1. **Comment:** **As stated in previous memoranda we doubt it will be possible to predict the results of aquatic toxicity tests based on physical or chemical sediment measurements or MICROTOX® tests with sufficient accuracy or precision for regulatory acceptance. However, if this methodology is successful it will be a benefit to many other ecological risk assessments in San Francisco Bay. Agreement on a correlation coefficient which is indicative of an 'acceptable' correlation is central to this methodology and should be the subject of further discussion among all parties.**

Response: See the responses to DTSC OSA general comment 1 and specific comment 2 (above).

2.5 EPA COMMENTS

GENERAL COMMENTS

1. **Comment:** **Most of the technical issues relating to the risk assessment process have been well thought out, however, there are a number of issues relating to the degree of conservatism in the risk assessment that are discussed in more detail below.**

Response: Comment acknowledged.

2. **Comment:** **The detection limits listed in these documents will not meet risk-based detection limits. Standard CLP procedures are inadequate for many of these analyses. It is strongly recommended that the detection limits be revised to ensure that risk-based levels are achieved (see Table 1 attached to these comments for recommended detection limits and methods for some of the analyses).**

TABLE 1
RECOMMENDED ANALYTICAL PARAMETERS AND METHOD DETECTION LIMITS FOR SEDIMENT AND PORE WATER SAMPLES

Sediment Parameter	Recommended Method Detection Limit	Recommended EPA Analytical Method
Grain Size	0.1%	Plumb (1981)
Total Organic Carbon	0.1%	EPA #9060
Arsenic	0.1 mg/kg dry wt	EPA #7061
Cadmium	0.1 mg/kg dry wt	EPA #7131
Chromium, total	0.1 mg/kg dry wt	EPA #7191
Copper	0.1 mg/kg dry wt	EPA #7211
Lead	0.1 mg/kg dry wt	EPA #7421
Mercury	0.02 mg/kg dry wt	EPA #7471
Nickel	0.1 mg/kg dry wt	EPA #7520
Selenium	0.1 mg/kg dry wt	EPA #7741
Silver	0.1 mg/kg dry wt	EPA #7761
Zinc	1.0 mg/kg dry wt	EPA #7950
Total PAHs	0.02 mg/kg dry wt	EPA #8270 or 8310
Total PCB Congeners	0.001 mg/kg dry wt	NOAA (1993) or Tetra Tech (1986)
Priority Pollutant Pesticides	0.02 mg/kg dry wt	EPA #8080

Response: The detection limits have been revised as appropriate and are reflected in revised Tables 11 through 15 of the QAPP.

3. **Comment:** **It is recommended that a sensitivity analysis be conducted to identify the "drivers" in the risk assessment process to quantify uncertainty. To decrease the uncertainty surrounding a risk estimation, more emphasis should be placed on collecting data to decrease uncertainty surrounding the main "drivers" in the risk estimate. Key parameters believed to affect risk should be input as reasonable ranges in the determination of the site-specific uncertainty.**

Response: The Navy requests guidance on the preferred methodology for performing a sensitivity analysis.

SPECIFIC COMMENTS

1. **Comment:** **WP Section 1.2, bullet 6 [5]. The use of MICROTOX® in marine sediment testing has had mixed results. Many times there is a "stimulatory" effect from sediment exposure. Because of the problems associated with stimulatory effects and the difficulty in interpreting these data in terms of ecological significance, it is recommended that the test results not be used in the ecological risk assessment should there be interpretation problems.**

Response: Based on conversations with Mr. Kelly Dowe (PRC 1995d) and Mr. Dan Pursell (PRC 1995e) of Microbics Corporation, the "stimulatory" effect is caused by two things: (1) hormesis, in which the bacterium produces more light than would be expected because of low levels of potentially toxic elements which are an indicator of toxicity, and (2) stimulation of light production caused by nutrient influences in adjusting for both the osmolarity and the ion composition of the test medium using sea salts and not natural sea water. Hormesis can be accounted for by the use of a comparison test (PRC 1995d), which Microbics developed and recommends to evaluate the effects of hormesis. The second effect, caused by increase in nutrients from the use of sea salts instead of natural sea water, can be controlled by ensuring that the test sample is close or equal to the control. If adjustments in test solution have to be made, natural sea brine should be used. For these reasons, the Navy feels that the stimulatory effect can be anticipated and accounted for.

MICROTOX® bioassay results will only be used as a sole indicator of risk if the MICROTOX® results correlate with the standard bioassay results.

2. **Comment:** **WP Section 2.4.1.1, page 9, paragraph 3. Please quantitatively describe the areal extent of the wetland areas at Hunters Point Annex (HPA) and**

describe how these areas will be assessed. For example, the kestrel may not be the most conservative choice for a terrestrial receptor in a wetland habitat. It is recommended that assessment and measurement endpoints be selected specifically for the wetland habitat.

Response: The total area of wetlands at HPA is approximately 7.10 acres. Wetlands will be assessed together with the intertidal habitats. The great blue heron and the willet are the avian assessment endpoint taxa thought to best represent exposure pathways of concern in this habitat. These receptors were selected specifically to assess the wetland and the adjoining mudflat habitats. The upland portion of the wetland in Parcel E is relatively insignificant when compared to the large area of nonnative grassland habitat in Parcel E, in which the American kestrel is known to forage.

3. **Comment:** **WP Section 2.4.1.2, page 9, sentence 1. It states that Parcel A "possibly" includes Threatened & Endangered (T&E) species, yet on pages 10 and 12 the peregrine falcon (a T&E species) has been positively identified at HPA. Please correct this discrepancy.**

Response: The text is correct as it stands. Although one sighting of a peregrine falcon has been made at HPA, the Navy has no evidence that the peregrine falcon or any other threatened or endangered species uses Parcel A for roosting or foraging.

4. **Comment:** **WP Section 3.1, page 14, sentence 2. There are terrestrial benchmark values that have been developed by Oak Ridge National Laboratory in the past two years (Suter et. al., 1994). They may be useful in the screening level approach.**

Response: Comment acknowledged. The methodology for derivation of TRVs presented in this work plan was formed, in part, by the methodology presented in the Oak Ridge National Laboratory report referenced in the comment (Suter et.al., 1994). The Navy appreciates mention of potentially useful references such as this one.

5a. **Comment:** **WP Section 3.2.2, page 18, paragraph 1. The group mean was used to develop hazard quotients (HQ) and hazard indices (HI). This is appropriately conservative compared to the upper 95th, but the distribution of the concentrations should be evaluated before a mean is selected. Highly skewed distributions would be more accurately reflected using the median.**

Response: The distribution of the concentrations will be reviewed, as suggested, when the HQs and HI are developed toward the end of phase 1B.

5b. **Comment:** **In addition, please clarify how the groupings were selected. It is important to consider the distance between sampling locations when determining the groupings. For example if the mean (or median) is used**

to develop HQs and HIs for screening purposes and the sampling locations are far apart, any one exceedance of a HQ (i.e., using the lowest value in lieu of the mean) could be detrimental (i.e., it may not be a hot spot since the areal extent can not be adequately evaluated). This information should be taken into consideration in the determination of data gaps and the subsequent sampling scheme for the Phase 1B work.

Response: The data used to develop the HQs and HIs were the analytical chemistry data obtained during the environmental sampling and analysis program (ESAP) studies at the 20 stations sampled. Each of the ESAP stations comprised an area of about 200- by 800-feet, in which five surface samples were collected and composited. The composited surface samples were then analyzed. One core sample was collected in the 200- by 800-foot area and analyzed. Therefore, there is no low or mean value, and this method is sufficient in providing tentative guidance in placement of sampling locations for phase 1B.

6. **Comment:** **WP Section 3.2.2, page 18, paragraph 2. Please list the chemicals detected at the site that do not have associated ER-L or ER-M values. Explain how these chemicals will be evaluated in the risk assessment.**

Response: Appendix A to the work plan contains a list of all chemicals detected at a site. Currently, new screening values are being developed using San Francisco Bay data. If certain chemicals are not included in these revised criteria, substitute screening criteria will be identified. See the response to RWQCB comment 1 (above).

7. **Comment:** **WP Section 3.2.2, page 18, paragraph 3. Explain why 10 percent was chosen as the contribution of the hazard quotient to the hazard index that represented COPCs driving the risk. Any HQ >1 could potentially be a risk-driver. Provide more justification of the selection of a 10 percent exceedance as a driving factor.**

Response: The purpose of using the 10-percent-cutoff was to prioritize chemicals of major concern at each site. Many chemicals contribute 0 to 10 percent of the hazard index, but only a few contribute greater than 10 percent, producing a clear break in the distribution. Chemicals which have a hazard quotient greater than 1 may pose a risk, but that risk is much less than the chemicals that contribute 10 percent or more of the hazard index.

8. **Comment:** **WP Section 4.2, page 20, paragraph 4. The proposed terrestrial endpoint for the American kestrel will be protection of the population, which is appropriate. However, because peregrine falcons are T&E species, the endpoint should be protection of the individual. Please change this in the text.**

Response: The text directs the reader to Table 4-2, which summarizes assessment and measurement endpoints. The first page of Table 4-2 states that the assessment endpoints are "protection of HPA populations and individuals of the following

organisms" and lists the peregrine falcon and other assessment endpoint taxa. However, for threatened or endangered assessment endpoint species, risk will be assessed based on individuals, rather than populations.

9. **Comment:** **WP Section 4.2, page 21, paragraph 1. Under what circumstances will exposure and effects be qualitatively analyzed? How would the methodology preclude use of a quantitative analysis? It is recommended that an outline be developed to list the contingencies, should a quantitative analysis become infeasible. Also, provide an outline of the circumstances and potential actions to be taken if there is a problem with performing a quantitative analysis.**

Response: The anticipated circumstances under which a qualitative exposure and effects analysis will be performed are presented on pages 21 and 22 of the work plan, and are briefly discussed below. The peregrine falcon and the California brown pelican are two assessment endpoint species for which it is anticipated that a quantitative analysis may be infeasible. Because these species are far-ranging and feed on prey from a variety of San Francisco Bay area locations and because their use of HPA is limited, they would generally not be considered appropriate assessment endpoints for a quantitative analysis of exposure to and effects of contaminants at HPA; however, the Navy chose to include them as assessment endpoints because of their conservation status. For these species, the large amount of uncertainty involved in a quantitative analysis of exposure and effects makes a qualitative analysis more appropriate.

Another reason that a quantitative analysis of exposure and effects would be infeasible for these two birds is the lack of a suitable measurement endpoint. For example, a preferred measurement endpoint for the peregrine falcon would be to calculate dose from tissue residues of shorebirds at HPA. However, the peregrine falcon's limited use of HPA does not appear to justify sacrificing a number of shorebirds for this purpose. Except for, possibly, the double-crested cormorant, which also is a far-ranging bird, the Navy does not at this time anticipate that qualitative analyses of exposure and effects will be necessary for any other aquatic avian assessment endpoint.

Qualitative analysis of exposure and effects will, like the quantitative analysis, be based on a weight-of-evidence approach. The weight-of-evidence approach will incorporate results of the quantitative analyses performed on other assessment endpoints that have phylogenetic or life and natural history similarities, as well as interpretation of the site conceptual model in light of contaminant concentrations in soil, sediment, and tissue and bioassay results, as appropriate.

10. **Comment:** **WP Section 4.2, page 22, paragraph 3. There is a grammatical error in the second to last sentence. Please change "assessment endpoints" to "receptors".**

Response: Comment acknowledged.

11. **Comment:** **WP Section 5.0, page 23, paragraph 2. Please confirm, in the text, that sediment chemistry and bioassay locations will be co-located (i.e., the sediment analytic and bioassays will be performed on samples from the same composite).**

Response: Sediment chemistry and bioassays will be performed using sediment from the same composite and the text in the FSP will be modified to reflect this..

12. **Comment:** **WP Section 5.0, page 23, paragraph 2. In the second sentence, add AVS/SEM to the list of factors affecting bioavailability.**

Response: The Navy agrees that acid volatile sulfides and simultaneously extracted metals (AVS/SEM) is a factor that affects bioavailability and will utilize during the assessment.

13. **Comment:** **WP Section 5.0, page 23, paragraph 3. Add a period to the first sentence.**

Response: Comment acknowledged.

14. **Comment:** **WP Section 6.2.1, page 26, paragraph 1. Boothman and Helmstetter have developed a new SOP (15 December 1993) for measuring AVS/SEM [Allen et al. (1991) was based on Boothman's last protocol]. Please contact Warren Boothman at the Environmental Research Laboratory, Narragansett for specific analytical differences and how these difference may or may not affect the interpretation of the results.**

Response: The new standard operating procedure (SOP) on determination of AVS/SEM by Boothman and Helmstetter (1993) has been obtained and reviewed. The SOP will be used instead of the one by Allen and others (1991).

15. **Comment:** **WP Section 6.2.2, page 28, paragraph 3. High-speed centrifugation without filtration will most likely cause a stimulatory response in *Photobacterium phosphoreum* (see Specific Comment #1).**

Response: See the response to EPA specific comment 1, above.

16. **Comment:** **WP Section 6.3.1, page 29, paragraph 1. Please ensure that depositional areas are sampled at the storm water outfall locations. Often storm water outfalls have erosional areas at the point of discharge. Sampling these erosional areas will not adequately characterize the contaminant load in the sediment contributed by the storm drains.**

Response: Every effort will be made to sample in depositional areas around outfalls at HPA using on-board depth meters.

17. **Comment:** **WP Section 6.4.1, page 31, paragraph 1. Standard EPA methods will not always meet risk-based detection limits. Please compare the detection**

limits to the risk-based values, to determine which analytes may need specialized methods (see General Comment #2).

Response: See the response to EPA general comment 2, above.

18. **Comment:** **WP Section 7.1.6, page 37, paragraph 1. Many times the reference locations chosen for a particular study are not true reference stations due to chemical contamination or physical differences, etc. It is recommended that performance standards be applied to both the reference area and control samples. For example, Puget Sound reference performance standards are listed in the table below. If the reference areas meet the performance standards, then numerically compare the mean site survival to the reference mean as described in this paragraph. If the reference areas do not meet the performance standards, use a statistical comparison to the control to determine effects.**

Puget Sound Sediment Performance Criteria

Bioassay	SMS Reference area/control performance standards	PSDDA Reference area/control performance standards
Amphipod	Control sediment < 10% mortality; reference sediment < 25% mortality.	Control sediment < 10% mortality; reference sediment < 20% mortality above control.
Bivalve larvae	Seawater control < 50% combined abnormality and mortality.	Seawater control <10% abnormality AND <50% combined abnormality and mortality; reference sediment < 20% combined abnormality and mortality normalized to control normal survivor counts.
Echinoderm embryo	Same as bivalve.	Same as bivalve.
Neanthes growth	Control sediment <10% mortality; reference sediment biomass ≥80% control biomass.	Control sediment <10% mortality; reference sediment biomass ≥80% control biomass.
MICROTOX	None	No numeric criteria for control sediment; reference sediment <20% light diminution over control.

SMS=Sediment Management Standards, Washington State Department of Ecology
PSDDA=Puget Sound Dredge Disposal Analysis, multi-agency group (EPA, COE, DOE, DNR)

Response: The Navy plans to use the reference stations to be proposed by the RWQCB

in its report, which is due in draft form in late September (PRC 1995f). This report will have to be reviewed and accepted by the agencies. However, because approval may not be obtained for some time, the Navy will use the reference station performance standards used in Puget Sound and provided in the comment.

19. **Comment:** **WP Section 7.2, page 37, paragraph 3. An invertebrate composite will best represent an avian diet provided the composite is of species typically composing the diet of the selected avian species. However, by compositing, information is lost on the relative lipid contents of the invertebrates and body burden estimates per species are not possible. It is recommended that key prey species of the receptors of concern be selected for collection and analysis. Multi-species composites for analytical purposes are generally not recommended (PSEP, 1989). It is recommended that individual composites by species be collected and analyzed. It is also recommended that the lipid content be analyzed in all of the fish and invertebrate tissue samples. Organics are normalized by lipid content and lipid content varies among species. For the purposes of the risk assessment, the analytical information can then be combined to represent the total contaminant concentration in the prey. Also, because avian species generally select fish species in a similar size range, it is recommended that a specified size range for fish be included in the work plan.**

Response: The composition of pooled invertebrate tissue samples and pooled fish tissue samples (separately pooled) will be proportioned consistently with diet contents of the aquatic avian assessment endpoint species, as appropriate. Available literature on the great blue heron indicates that this bird is opportunistic (for example, Butler 1993), suggesting that pooling fish species for tissue analysis is appropriate. Diet composition of all aquatic avian assessment endpoint species will be researched to guide the pooling of invertebrate and fish tissue residue samples. Invertebrates and fish collected will also be of appropriate size class, as indicated in the literature.

Due to budget concerns, tissue residues of individual invertebrate and fish species cannot be analyzed separately. The Navy believes that taking a pooled sample of species representing the diets of assessment endpoints is preferable to relying solely on the tissue data from one invertebrate or fish species.

The Navy is aware that tissue residue data for lipophilic contaminants are often normalized for the lipid content of the organism sampled. However, the conditions under which this practice is appropriate are not agreed upon by wildlife toxicologists and appear to depend upon the contaminant in question and its statistical relationship to lipids (Hebert and Keenleyside 1995). Because at HPA the primary goal of analyzing tissue residues of field-collected invertebrates and fish is to use these data to calculate a dose for assessment endpoint taxa, and because tissue samples will consist of multiple species, determining the lipid content of the sample (composed of more than

one species) may be inappropriate. However, the Navy will further consider the necessity of using lipid-normalized data in calculating biomagnification factors as additional information is obtained.

20. **Comment:** **WP Section 7.2.1, page 38, paragraph 1. The two grab samples suggested in the work plan are inadequate for collection and characterization of invertebrates. At a minimum, five grab samples per sample location of sediments should be collected for invertebrate samples due to the diversity in abundance and patchy distribution of benthic organisms.**

Response: The proposed grab samples for collection and characterization of organisms are not being collected to conduct a community analysis assessment. The grab samples are being collected only to expand knowledge of the food web in the offshore area of HPA. Therefore, two grab samples at each location should be sufficient.

21. **Comment:** **WP Section 8.1, page 39, step 2. The location poses a potential risk to benthic receptors if either the HIs or HQs are greater than one. Please revise the text to include HQs > 1 as indicating a potential risk.**

Response: The Navy acknowledges that if the HQ or HI is greater than 1, then the location poses a potential risk for benthic receptors and an HQ or HI less than 1 would indicate that the location does not pose a risk to benthic receptors, and no remedial action should be required at that location.

22. **Comment:** **WP Section 8.1, page 39, step 3. A correlation analysis should also be performed on HQs and individual chemicals. An individual chemical will often have a positive correlation with detrimental effects.**

Response: Correlation analysis will be performed on HQs and individual chemicals.

23. **Comment:** **WP Section 8.1, page 39, step 4. Please see specific comment #23 [22].**

Response: When performing the assessment, if a positive correlation (correlation coefficient > 0.5) between the HQ or HI and toxicity test results is found, the HQ or HI will be considered to correlate with toxicity. Stations without direct toxicity tests can then be evaluated using only the HQ or HI with greater confidence.

24. **Comment:** **WP Section 8.2.1.1, page 41, paragraph 1. Give an example of how the exposure duration (ED) will be used in the exposure assessment. It states that an ED = 1 will be used for receptors that are year-round residents of the "assessment area." How will the "assessment area" be determined and how does this differ from the "area of contamination (AC)" described in the following paragraph?**

Response: Based on the Navy's discussions with regulatory representatives of EPA and DTSC, it was agreed that because the dose is calculated on a per-day basis,

the ED should be equal to 1 in all cases.

25. **Comment:** **WP Section 8.2.1.1, page 41, paragraph 2. In the calculation of the "site use factor (SUF)" how will the "area of potential exposure (APE)" be determined? It is acknowledged that home range estimates are not always accurate, yet estimating foraging areas without a detailed scientific investigation could result in over or under estimates of actual site use by the receptor. There is a concern that the SUF and the ED stated in Specific Comment #24 may not give conservative or even realistic estimates of exposure. It is acknowledged that by using these factors an attempt is made to give a more realistic explanation of exposure but that is dependent on the accuracy of the data used in developing these exposure factors. Please provide examples and more detail to ensure a conservative and realistic estimate of exposure will be developed.**

Response: A range of home range estimates will be gathered from the scientific literature to calculate high and low doses. These estimates will be based, as much as possible, on similar habitats, diet composition, and life stage. To calculate the high dose estimate for an assessment endpoint receptor, the lowest appropriate estimate of home range found in the literature for that species will be used. In calculating the SUF, the APE will be equal to this home range estimate. The Navy believes that using the lowest estimate of home range in calculating a high dose, along with using the other high dose estimate parameters, will bracket the upper end of the high dose range. As stated in the response to EPA comment 24 above, the ED will not be used in the dose calculation equation.

26. **Comment:** **WP Section 8.2.1.1, page 41, paragraph 2. How will the "area of contamination (AC)" be determined? Many of the sampling locations are from 60-500 meters in distance from each other. How will the area between the sampling locations be determined? If there is an exceedance of an HQ or HI and detrimental effects at a particular station, does the area of contamination extend to the next sampling point?**

Response: The AC will be determined using the Thiessen polygon construction methodology, as described by Clifford and others (1995). This methodology constructs polygons around sampling points by creating a triangular irregular network using all points (on a nearest-neighbor basis) and then by using the perpendicular bisectors of each line connecting data points to define the polygons (Clifford and others 1995). The sediment (for the mudflat and wetland areas) or soil within the polygon will be assumed to have the same contaminant concentration as the sampling point located within the polygon. The AC for dose calculation will be based on these polygons, and the area of potential exposure, that is, the foraging range of the receptor, will be compared to areas of contamination of varying contaminant concentrations to calculate the SUF. This clarification will be added to the work plan.

27. **Comment:** **WP Section 8.2.1.2, page 43, paragraph 1. Averaging the diet over the**

year may not be a conservative estimate of exposure. During the reproductive period the diet intake will substantially increase and exposure to COPC may increase. It is recommended that a dietary intake range be used or evaluated to see the effect on the exposure estimate.

Response: The Navy agrees with this comment. Ingestion rate will be added as a dose equation parameter that will vary in calculating high and low dose estimates. For year-round resident assessment endpoint species, a high ingestion rate reported in the literature will be used to calculate the high dose estimate, and an average ingestion rate from the literature reported values will be used in the low dose estimate. If the TRV selected for the chemical of potential concern (COPC) and assessment endpoint in question demonstrates a gender-specific effect, then gender-specific ingestion rates will be sought. Furthermore, estimates of ingestion rate will be based, as much as possible, on similar habitats, diet composition, and life stage. For all dose estimates, the range of values obtained from the literature for each dose equation parameter (such as ingestion rate) will be presented, and the values used in their calculation will be indicated.

28. **Comment:** **WP Section 8.2.1.3, page 44, proposed table. Include all of the input parameters used in developing the exposure estimate (e.g., SUF, AC, ED, APE). It is recommended that ranges be presented in the table, along with the actual number selected for use. Include (as a footnote or separate column) the reference used for each number.**

Response: Please see the response to EPA comment 27 above. All sources will be referenced.

29. **Comment:** **WP Section 8.2.1.4, page 45, bullet 6. Under what circumstance will the 95th UCI or the maximum concentration be used (e.g., will this be dependent on the number of detects)?**

Response: For threatened or endangered species, the high dose estimate will use the maximum contaminant concentration detected in soil or sediment, and the low dose estimate will use the contaminant concentration equal to the 95th percent lower confidence interval (95th LCI) of the mean. For species that are neither threatened nor endangered, the high dose estimate will use the contaminant concentration equal to the lower of either the 95th percent upper confidence interval (95th UCI) of the mean or the maximum, and the low dose will use the mean contaminant concentration.

30. **Comment:** **WP Section 8.2.2.2, page 49, paragraph 1. Provide the range of TRVs used for selecting the final low and high TRVs.**

Response: The range of TRVs derived will be presented for each COPC and assessment endpoint, and the high and low TRVs will be indicated in the final report.

31. **Comment:** **WP Section 8.2.3, page 50, paragraph 3. It is recommended that all risk**

estimates (i.e., not just the intermediate risk estimates) be evaluated according to the criteria listed in this paragraph. Alternatively, a quantitative uncertainty analysis should be performed.

Response: For each assessment endpoint and COPC, a weight-of-evidence evaluation of the criteria listed in the paragraph will be used to evaluate risk, regardless of the results of the hazard quotient calculation. The results of the hazard quotient calculation will be one of the pieces of evidence in the weight-of-evidence approach to risk assessment.

32. **Comment:** **WP Section 9.1, page 52, paragraph 3. What small mammal and which trophic level will be used in the dose estimate? For example, a shrew (carnivore) may be more highly exposed than a vole (herbivore). Because a shrew's diet consists of earthworms and the earthworm gut can contain a significant amount of soil, the shrew is exposed to COPCs through direct soil ingestion, indirect soil ingestion from within and on the earthworm, and accumulation of COPCs in the tissue of earthworms. Please ensure that the risk estimate is adequately conservative for the receptors at the site.**

Response: The methodologies for any further terrestrial investigations, if necessary, will be presented in a separate work plan for those investigations. If small mammal tissue analysis is performed, the species of small mammal collected will ultimately depend on which species are present at HPA. The Navy agrees with this comment and will select the most appropriate food web pathway to model.

33. **Comment:** **WP Section 9.2, page 53, paragraph 6. If selection of bioaccumulative COPCs will be based on a screening exposure and effects model using the kestrel, it is imperative that the model be adequately conservative for all organisms at the site (i.e., a shrew model should indicate less risk than the kestrel model). In this screening level exercise, it is recommended that receptors at the site be evaluated for the most conservative scenario. Revise the text to include an approach for accomplishing this task.**

Response: Please see the responses to DTSC OSA specific comments 3, 9, and 10 (above). The Navy believes that the screening assessment presented in sections 9.1 and 9.2 of the work plan, with the modifications discussed in the responses to the comments listed above, provides for evaluation of the most conservative terrestrial scenario.

34. **Comment:** **WP Section 9.3, page 55, paragraph 4. Although a greater proportion of a kestrel's diet may be from ingestion of voles (herbivores), the greater proportion of contaminant loading may be from ingesting a carnivore such as a shrew. It is recommended that a simple sensitivity analysis be conducted to ensure that an adequately conservative scenario is developed before tissue samples are collected.**

Response: Whether the greater proportion of a contaminant load derives from the kestrel's ingestion of an herbivorous or a carnivorous small mammal also depends upon the bioaccumulative properties of the contaminant in question. (Please see the responses to EPA general comment 3 and EPA specific comment 32, above).

35. **Comment:** **WP Figure 2-1. Provide a clear demarcation of parcels. It is difficult to distinguish between the parcels.**

Response: When Figure 2-1 is reproduced, a clearer demarcation between the parcels will be provided.

36. **Comment:** **WP Figure 2-4. In section 9, additional assessment endpoints were evaluated. Please update this figure to include the additional endpoints.**

Response: The Navy is uncertain which additional assessment endpoints the comment addresses. The receptors to be used as models in the screening assessment (sections 9.1 and 9.2) are represented in this food web, but they are not represented as assessment endpoints because this effort is at the screening level. The American kestrel is the only assessment endpoint and small mammals and terrestrial invertebrates are the only measurement endpoints discussed for the potential future investigations (section 9.3), and both are represented in Figure 2-4.

37. **Comment:** **WP Figures 3-7 through 3-10. It is recommended that this information be taken a step further in the final report (not in the revised work plan) by grouping sites, along with their HQs, HIs, and the additional data collected in Phase 1B to develop clusters of contaminated areas and hot spots. A large uncertainty will be in determining boundaries and this particular point should be carefully thought out before sampling begins.**

Response: The final report will incorporate similar information as indicated in Figures 3-7 through 3-10. The stations that have been chosen for sampling offshore during phase 1B at HPA were selected to determine a gradient of contamination from a stormwater outfall out into the Bay.

38. **Comment:** **WP Figure 4-5. Please update this figure to reflect the current work plan (e.g., pelagic fish are no longer a measurement endpoint).**

Response: Figures 2-4, 2-5, and 4-5 are being revised to reflect the current work plan.

39. **Comment:** **WP Figure 6-1 through 6-4. It is not clear why different bioassays are proposed along the transects. For example, in figure 6-1, the last sediment location along the transect has a suite of bioassays, yet one transect only shows MICROTOX as the bioassay. This discrepancy also occurs in various locations along the other transects. How will the information obtained from this schematic be interpreted? Please specify why a suite of bioassays were chosen for some locations and why only**

MICROTOX or just sediment chemistry was chosen for other locations. A full suite of bioassays and chemical analyses is recommended for all biological test locations.

Response: A full suite of bioassays cannot be done at all locations proposed because the cost would be prohibitive. Wherever the amphipod and echinoderm bioassays are being conducted, the MICROTOX® bioassay will also be conducted (37 locations) to assess the correlation between the amphipod and echinoderm bioassays and the MICROTOX® bioassay. If there is a positive correlation, then the MICROTOX® test can be used as a surrogate for the amphipod and echinoderm tests to indicate toxicity and applied to the 35 stations where only the MICROTOX® bioassay is planned. The choice of bioassay locations was to locate one full suite of bioassays along each transect and then strategically locate the additional MICROTOX® tests throughout the offshore area. All transects in Figure 6-1 have at least one full suite of bioassays.

40. **Comment:** **WP Figure 8-2. Will the ranges of uncertainty factors be used in the derivation of the TRV or will just one uncertainty factor be used, depending on the available data? It is recommended that justification be provided in the final report for the choice(s) of uncertainty factors.**

Response: The conditions under which uncertainty factors will be used to derive TRVs will vary according to the quality and the quantity of toxicity data that is available and collected for assessment endpoint taxa and COPCs. Justification of the use of uncertainty factors will be provided in the final report. Please also see the response to EPA specific comment 30, above.

41. **Comment:** **WP Tables 3-6 and 3-7. This table is very informative. It is recommended that an additional table be developed to illustrate exceedances of HQs. For example, in parcel C (station 17), lead is approximately six times the HQ-L and one times the HQ-M, illustrating a substantial elevation over the effects-based value. At this same location, endrin is approximately 200 times the HQ-L and 1.28 times the HQ-M. If only the HIs are used, according to table 3-7, lead is not listed as a "significant" chemical under exceedances of an HI-L. The extremely high exceedance of endrin effectively "masks" the significant contribution that lead may have.**

Response: A table listing the exceedances of HQs will be prepared for the final report. Both HQs and HIs will be examined. The Navy does not believe that the development of this table for the WP will benefit the sampling program since the transects have already been selected on the basis of this data.

42. **Comment:** **WP Tables 4-2 and 9-1. It is recommended that this information be used to select species for the purposes of tissue analyses. Instead of compositing everything that is collected, attempt to identify key prey species to be collected for the purposes of tissue analyses.**

Response: These and other data on dietary preferences of aquatic avian assessment endpoints will be used to identify relevant prey species to be collected for tissue residue analysis. Please see the response to EPA specific comment 19, above.

43. **Comment:** **WP Table 7-2. Please update this table according to the information provided in Specific Comment #19 [18].**

Response: See response to EPA specific comment 18, above. The revised Table 7-2 is as follows:

Bioassay	Reference Area/Control Performance Standards
Amphipod	Control sediment less than 10 percent mortality; reference sediment less than 20 percent mortality above control.
Echinoderm Embryo	Seawater control less than 10 percent abnormality and less than 50 percent combined abnormality and mortality; reference sediment less than 20 percent combined abnormality and mortality normalized to control normal survivor counts.
Polychaete Growth	Control sediment less than 10 percent mortality; reference sediment biomass greater than or equal to 80 percent control biomass.
MICROTOX®	No numeric criteria for control sediment; reference sediment less than 20 percent light diminution over control.

44. **Comment:** **FSP Section 3.2.1.3, page 8, paragraph 2. Please include redox potential as a conventional parameter to be analyzed.**

Response: Redox potential will be measured with the other parameters.

45. **Comment:** **FSP Section 3.2.2.3, page 9. Include TOC and grain size in the core analyses. This information is useful in determining anthropogenic inputs and historical sediment deposition.**

Response: Analyses of total organic carbon (TOC) and grain size will be performed on each core segment, including the surface segment.

46. **Comment:** **FSP Section 3.3.1, page 10. Do not pool invertebrate species (see Specific**

Comment #20). If possible, composite two or three key prey species. Also include lipid analyses for normalization procedures.

It is also recommended that if sufficient biomass is not available at all of the sites, perform the bioaccumulation study on all of the sample locations. This will help in the interpretation, especially if half of the areas have site-specific tissue samples and half of the areas do not.

Response: Please see the response to EPA specific comment 19. The methods for identifying sites for bioaccumulation studies if sufficient biomass is not available for tissue analysis will remain as stated in the work plan.

47. **Comment:** **FSP Section 3.3.2, page 10. A van Veen grab is inappropriate for the collection of fish species. Either seine or trawl for fish species.**

Response: If fish are collected, they will be small species with small home ranges such as gobies for which a net will be used.

48. **Comment:** **FSP Section 4.0, page 14. If small mammals are collected, please composite by species.**

Response: As discussed in section 9 of the work plan, if the screening assessment indicates potential risk, small mammal tissue residue analysis may be used to evaluate risks to terrestrial receptors in Parcel E. The methodological details of any small mammal collection and analysis will be discussed in a separate work plan if the screening assessment indicates potential risk and further investigations prove necessary. Please also see the response to EPA specific comment 32, above.

49. **Comment:** **QAPP Section 1.0, page 2, paragraph 1 and Tables 11-15. Standard CLP methods will not give detection limits suitable for ecological risk (see General Comment #2). For example, a detection limit of 30 ppb should be achieved for TBT to reach risk-based detection limits. Table 15 lists a detection limit of 2.2 ppm for TBT.**

Response: See response to EPA general comment 2, above. The detection limit for tributlytin (TBT) in Table 15 has been revised to 5 micrograms per kilogram (μg/kg) in sediment and 0.05 micrograms per liter (μg/L) in pore water.

50. **Comment:** **QAPP Section 8.8, page 52, paragraph 3. Please evaluate the new AVS/SEM method (Boothman and Helmstetter 1993) to determine if a change in protocol is warranted. If the 1993 protocol is not used, please describe, in detail, why the latest version was not incorporated into this document (see Specific Comment #14).**

Response: The Boothman and Helmstetter AVS/SEM SOP (1993) will be incorporated into the project instead of the method by Allen and others (1991).

51. **Comment:** **QAPP Section 8.10.2, page 57, bullet 2. Mortality in any one control replicate must not exceed 20 percent.**

Response: The QAPP follows EPA guidance which does not state that mortality in any one control replicate must not exceed 20 percent (EPA 1994). Therefore, this comment will not be incorporated.

52. **Comment:** **QAPP Section 8.10.2, page 58, bullet 11. Do not feed the test organisms. This test is designed to be used without food additions.**

Response: The bullet item will be deleted.

53. **Comment:** **QAPP Section 8.10.3, page 62, paragraph 1. Include information on holding times to ensure the organisms are held in the laboratory for the appropriate length of time (and that they do not exceed holding times) for each bioassay.**

Response: The information will be incorporated.

55. **Comment:** **QAPP Section 8.11, page 64, bullet 1. Please describe the size range to be used at the initiation of the test. Also, include text describing the test design to ensure adequate biomass will be recovered for detection of target analytes.**

Response: The test is initiated with polychaetes that range in size from 2 to 4 inches and weigh about 0.9 to 1.0 gram each. If the same size individuals are used to start the test, then enough biomass will be available for analysis at test termination.

56. **Comment:** **QAPP Section 10.0, page G-9. Include the reburial protocol (in clean sediment) as an additional bullet.**

Response: The following bullet will be added to Section 10.0, page G-9:

- The amphipods from each replicate will be collected into a 1-liter beaker containing clean control sediment and exposure water. The number of amphipods unable to rebury themselves in the control sediment after 1 hour will be recorded.

2.6 EPA's QUALITY ASSURANCE MANAGEMENT SECTION COMMENTS

1a. **Comment:** **According to the FSP, several plan elements and procedures required to be covered in the FSP are located in the WP, QAPP, and the IDW plan.**

EPA guidance states that the FSP is a "stand alone" document and may not reference field procedures in other documents except for background information. It is recommended that the following elements and information be specified in the FSP:

- **rationale for all sampling locations and analytical parameters;**
- **action levels;**
- **description of analyses to be performed;**
- **quantitation limits for all analyses and matrices;**
- **container types for sediment and tissue samples;**
- **the container source;**
- **required samples volumes for all matrices and analyses;**
- **quality control (QC) sample identification, types (i.e., field duplicate, laboratory QC, equipment, field and trip blanks), rationale, frequency, and analytical parameters;**
- **sample holding times;**
- **sample preservation methods; and**
- **the disposal of IDW.**

If it is deemed necessary or appropriate to reference other documents, these documents should be made available in the field during sample collection activities.

Response: The original plan was to include the FSP and QAPP as appendices to the work plan. However, since the work plan and the QAPP are very large documents in themselves, it was decided to separate each of the three documents. The Navy intended for the reviewers to have access to all three documents. The Navy intends for everyone involved in the project to have a copy of all three documents and therefore be able to refer to the appropriate document as necessary. The QAPP and the FSP will be revised as necessary, and the changes will be redlined; however, the sections listed in the comment above, will not be included. The three documents will be submitted together in one binder which will contain a copy of the response to comments.

1b. **Comment:** **The laboratory chosen to perform analyses on the sediment and tissue samples should be made available in the field during sample collection activities.**

Response: A laboratory has not yet been identified, but will be as soon as all of the pertinent documents (work plan, FSP, and QAPP) have been finalized.

2a. **Comment:** **[Section 2.1, Sediment Sample Handling]**

Equipment decontamination procedures provided in Section 2.1 are not consistent with EPA recommended procedures. Any modifications to EPA

procedures should be discussed in the FSP.

Response: The decontamination procedure will be modified to read as follows: "Bowls, utensils, and other sampling equipment that may come in contact with samples will be washed with laboratory-grade detergent (such as Alconox), rinsed with sea water, rinsed with a 10 percent hydrochloric acid rinse, rinsed with laboratory grade methanol, and allowed to airdry."

2b. **Comment:** **Section 2.1 provides only general guidance for the packing and shipping of sediment samples. Specific sample packaging and shipment procedures specified in the EPA regional guidance document utilized for this review should be incorporated into the FSP. These include the method of shipment (overnight air, ground, etc.) and the shipping schedule.**

Response: All samples will be shipped daily to the designated laboratory by Federal Express® overnight air unless the laboratory is within a 1-hour drive of the project site. If the laboratory is within a 1-hour drive of HPA, then arrangements will be made with the laboratory to pick up the samples on a daily basis.

2c. **Comment:** **Examples of field QC summary forms, chain-of-custody forms, and sample labels should be provided in the FSP.**

Response: These examples are included in the QAPP and will not be reproduced in the FSP.

2d. **Comment:** **Section 2.0 should specify that the analytical parameter be included on every sample label.**

Response: This will be incorporated into Section 2.0.

3. **Comment:** **[Section 4.0, Onshore Investigation Activities] Section 4.0 discusses in general terms the collection of small mammals in order to characterize the onshore mammalian community that may serve as prey for target raptor species. However, trapping methodologies are not specified and Section 4.0 states '[t]rapping methodologies will be detailed at a later date". The document which will contain the trapping methodologies should be specified in Section 4.0**

Response: Please see the responses to EPA specific comments 32 and 48, above.

4. **Comment:** **[Section 5.0, Investigation-Derived Waste] This section references the PRC document, "IDW Waste Management Plan" for the disposal of all investigation-derived waste such as the methanol used for equipment decontamination. This document should either be included in the FSP or more specific disposal procedures and requirements should be provided in Section 5.0.**

Response: More detail for handling and disposal of investigation derived waste (IDW) has been included in Section 5.

5a. **Comment:** **[Table 1, Sample Locations and Analyses] Although the total number of samples, sample types, and number of samples for each analysis are provided in Table 1, a weekly sampling schedule, container types, sample volumes, preservatives, contractual and technical holding times, and field and laboratory QC samples are not included. EPA guidance recommends that this required information be included in tabular form on a sample by sample basis. Also, separate tables should be provided for each matrix, including pore water.**

Response: Table 1 has been modified and two additional tables have been added to the FSP address this concern.

5b. **Comment:** **Table 1 lists several analyses twice, thus making this format unclear.**

Response: Table 1 has been modified to correct this problem.

5c. **Comment:** **The analysis of pore water is discussed throughout the FSP. The description for pore water extraction should be expanded to include specific procedures and required equipment, and to identify personnel responsible for pore water extraction.**

Response: The information is in the QAPP, Appendix F.

5d. **Comment:** **Pore water samples are not treated as a separate matrix in Table 1. A unique sample location identification should be assigned to the pore water resulting from the centrifugation of the composite sample collected at each sample site.**

Response: Table 1 has been modified to address this comment.

5e. **Comment:** **The analytical methods for tissue samples are not specified in Table 1. Specific analytical methods to be used for the analysis of tissue samples should be provided in Table 1.**

Response: Table 1 has been modified to address this comment.

FIELD SAMPLING PLAN SPECIFIC CONCERNS

1. **Comment:** **[Section 3.2.2, Core Samples] This section indicates that eight 3-foot cores will be taken to characterize the vertical extent of contamination. However, Table 1 lists nine 3-foot cores to be collected. This discrepancy should be addressed.**

Response: Table 1 has been modified. Eight 3-foot cores will be collected.

2. **Comment:** **[Section, 3.4.1, Location Identification System; Section 3..4.2, Sample Identification System] The location identification system identified in Section 3.4.1 is not consistent with Table 1. Specifically, the designation codes for the sample types are not incorporated into Table 1 which lists samples according to "Sample Location I.D.". The sample identification system specified in Section 3.4.2 is consistent with the information regarding sample identification in Table 1. Table 1 should be corrected to include the sample type designation or rename the "Sample Location I.D." column as "Sample Identification".**

Response: Table 1 has been modified to address this comment.

WORK PLAN GENERAL COMMENTS

1. **Comment:** **[General] The WP provides a rationale for data uses and a thorough review of the project design. However, specific statements regarding quantitative data quality objectives (DQOs) and the project quality assurance/quality control (QA/QC) criteria have not been provided in the WP. Although general statements are provided for DQOs for Phase 1B activities, the WP does not express DQOs in terms of numerical goals for accuracy , precision, completeness, representativeness, or comparability. If specifying quantitative goals is not relevant for total measurement of Phase 1B activities, a rationale and discussion should be provided in the WP.**

Response: The DQOs and the project QA/QC criteria are included in the project-specific QAPP, Section 3.2.

3.0 RESPONSE TO COMMENTS ON THE PHASE 1B ECOLOGICAL RISK ASSESSMENT QUALITY ASSURANCE PROJECT PLAN

The following sections present the responses to comments on the phase 1B ecological risk assessment QAPP (PRC 1995c).

3.1 DTSC COMMENTS

1. **Comment:** **Page 34, section 8.0 states that the subcontract laboratory will be certified by the California Department of Toxic Substances Control (DTSC) and approved by the Navy. Please note that DTSC does not certify environmental testing laboratories. The certification of environmental testing laboratories is administered by the California Department of**

Health Services. The draft document refers and/or specifies laboratory QA plan and other laboratory commitments without naming the actual laboratory (e.g., page 74, section 10.2.2 Laboratory Data). It is not clear whether or not an existing willing and able laboratory is ready to provide the referred laboratory QA plan and/or to perform the specified commitments.

Response: The subcontracted laboratory will have current certification from DHS Environmental Laboratory Accreditation Program (ELAP).

A specific laboratory was not named in the draft QAPP because the competitive procurement for the laboratory has not been finalized. The selected laboratory will meet the technical requirements outlined in the QAPP, and any deviations or modifications will be appended to the QAPP and submitted for regulatory agency review. After the laboratory has been contracted, laboratory-specific standard operating procedures (SOP) for the methods or activities outlined in this QAPP will also be available for agency review.

Because of the nature of the work described in the QAPP, the subcontracted laboratory will have to have experience dealing with bioassay and bioaccumulation tests protocols, and also possess strong analytical capabilities and refined instrumentation.

2. **Comment:** **Page 51, Table 15, parameters like Total Organic Carbon, Sulfide, Ammonia, Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM) may not have specific contract-required detection limits (CRDL), but the detection limits achievable by the methods either in terms of the method detection limit or quantification limit used for analyses should be provided.**

Response: Table 15 will be amended to include the CRDLs for the methods mentioned above, as follows:

	Sediment or Tissue	Pore Water
Analyte	**CRDL**	**CRDL**
TOC	1 mg/L	Not measured
Grain size	0.0001 grams dry weight	Not measured
SOD	0.1 mg/L	Not measured
Sulfide	Not measured	0.01 mg/L
Ammonia	0.01 mg/L	0.01 mg/L

AVS/SEM	5.0 mg/kg	Not measured

3. **Comment:** **Page 70, section 9.3 states that the laboratory will analyze other QC samples that measure the laboratory's analytical accuracy, precision, and representativeness. It is not clear how the analysis of QC samples would measure the representativeness of the laboratory. Representativeness is normally considered a quality measure for sampling. At the laboratory level, representativeness may involve subsampling and sample homogeneity.**

Response: The word "representativeness" will be deleted from the first sentence in Section 9.3.

4. **Comment:** **Page 77, section 11.0 discussed performance, system, and field audits. It is generally too brief and not specific.**

Examples are: "Audits will be performed at scheduled intervals by the QA program manager, project QA officer, or senior technical staff". "Scheduled intervals" should be made specific such as once per month or once per three months, etc.

Response: Two types of performance audits will be conducted: (1) single-blind performance evaluation (PE) samples, and (2) split-sampling with the regulatory agencies. The subcontracted laboratory will be required to perform the analysis of single-blind PE samples once, at the beginning of the project. The PE samples will be coordinated among Environmental Resources Associates (ERA) (the Navy's supplier of PE samples), the subcontracted laboratory, and the Navy's project chemist. The split-sampling event will be coordinated between EPA's representative and the Navy's project chemist. At present, one split-sampling event is foreseen during the course of the sampling event.

Systems audits are usually scheduled at the beginning of the project, and their main purpose is to ensure that quality control systems are in place and functioning properly. Unless the subcontracted laboratory experiences systems failures that require assistance from the Navy's biologist or chemist, or the project's duration is longer than 6 months, a one-time system audit is routine.

Field audits are conducted at a minimum of once every 3 months. Field audits are implemented by the project manager.

5. **Comment:** **"Audits may include reviews of project plan adherence, training status, health and safety procedures, activity performance and records, budget status, QC data, calibrations, conformance to SOPs, and compliance with laws, regulations, policies, and procedures". The statement may require the audits to include none, one or more of the elements mentioned.**

Response: All of the elements cited in the above-mentioned paragraph are audited either during a performance, system, or field audit. For example, the field audit will check for adherence to the project plan, health and safety procedures, and activity performance and record keeping, while a system audit will check for training status, QC data, calibration, and activity performance and records. A sentence will be added that states, "A performance, system, or field audit may require checking for one or more than one of the elements mentioned above."

6. **Comment:** **"A performance audit is a review of the existing project and QC data to determine the accuracy of a total measurement system or a component of the system. Laboratory performance audits are conducted routinely by the Navy and PRC". A very important aspect of a performance audit is the analysis of proficiency test samples (performance evaluation samples) by the concerned laboratory. So, the analyses of proficiency test samples should be considered. "Routinely" should be made specific as discussed above with regard to "scheduled intervals".**

Response: See the response to DTSC comment 4, above.

7. **Comment:** **Page A4, Table 1-4, it is not clear why precision in terms of relative percent difference (RPD) is NA (not applicable) for analyses like Organotins, 1,3-Dinitrobenzene, and AVS/SEM while the recovery limits are available.**

Response: RPDs for organotins and 1,3-dinitrobenzene for pore water and sediments and AVS/SEM (sediment only) have been specified. See amended Table A-4.

3.2 EPA COMMENTS

GENERAL COMMENTS

1. **Comment:** **There is a concern that the analytical methods proposed in the QAPP may not provide the information needed to evaluate possible ecological risk. The CLP methods for chemical analysis enumerated in the QAPP may not provide low enough limits to detect certain contaminants of concern in San Francisco Bay sediments.**

Response: See the response to EPA specific comment 1a, below.

2. **Comment:** **Several procedures proposed for the Development Abnormality Toxicity Test with Strongylocentrotus purpuratus should be modified. It is suggested that the Standard Operating Procedure be replaced by the new EPA draft protocol, which accompanies this review.**

Response: The protocol in Appendix E will be modified to reflect the modifications reflected in the EPA draft SOP.

3. **Comment:** **In addition, it is not clear that the logistics of sample work-up, especially the preparation and use of pore water, have been fully analyzed. The Work Plan, which calls for a large number of sediment samples to be collected, also requires analysis of the pore water from those sediments. It is most important that the laboratory or laboratories contracted to perform these analyses have the capacity to produce and process the large volumes of pore water in a timely manner. Alternatively, methods using smaller volumes of sample, provided they achieve the required detection limits, should be researched.**

Response: To achieve the detection limits requested does require large volumes of pore water and therefore sediments to obtain the required volumes of pore water. Based on work at other sites, the Navy is aware that it is critical for the contracting laboratory to be able to handle such large volumes of sediment for pore water extraction. The laboratory that is selected will need to create a plan to address the handling of expected volumes of sediment for pore water extraction. Laboratories have been contacted in regarding the centrifugation and have stated that they have the capacity to handle the volume of sediment.

SPECIFIC COMMENTS

1a. **Comment:** **Section 1.0: Introduction. This section contains the general statements regarding intention to use EPA CLP methods for chemical analysis of sediment, pore water and tissue. Unmodified CLP methods may not be appropriate for achieving meaningful detection limits for marine sediments. This issue should be discussed briefly in the introduction and more fully in the appropriate sections.**

Response: The following statement will be added: "Modified CLP methods, specifically those modifications outlined in EPA's document, 'Superfund Analytical Methods for Low Concentration Water for Organic Analysis', dated October 1992, will be performed for the pore water analysis." The resultant improved detection limits for pore water analysis have been entered into revised Tables 11 through 15. For sediment and tissue matrices, other modifications will be proposed in order to achieve lower detection limits.

Also see the response to EPA specific comment 5a, below.

1b. **Comment:** **The echinoderm bioassay protocol should reference the latest EPA version.**

Response: The proposed modification has been made.

2. **Comment:** **Section 3.5: Representativeness. In addition to the definition of representativeness presented here, a brief discussion of the method by which it was determined that this objective is being met by the sampling design should be included here.**

Response: Representativeness is ensured by adhering to a rigorous consultation process, in which all stakeholders are given an opportunity to discuss the sampling rationale, sampling locations, number of samples collected, sampling protocol, species to be tested, and so forth. As part of the development of the ecological phase 1B work plan and its companion QAPP, three meetings were held to discuss all aspects of this project. Consensus was achieved after 8 months of consultation. Dr. Clarence Callahan, the Biological Technical Assistance Group (BTAG) coordinator for EPA Region 9, invited the Navy to present to the BTAG its recommendations to improve the ecological risk assessment process at Navy installations on April 24, 1995. The Navy's presentation consisted of three parts: (1) screening of sediments based on ecologically relevant regulatory criteria, (2) testing the toxicity of sediments using standard bioassays, and (3) interpreting the results and predicting the overall effect of the contamination using ecological modeling. The presentation was attended by representatives from EPA, DTSC, and RWQCB. The benefit of coordination among projects within San Francisco Bay was recognized. The Navy and the regulatory agencies agreed to work toward consistency in conducting ecological risk assessments on Navy property.

Some of the ways representativeness has been satisfied in the sampling design for this project are as follows:

- Bioassay test species were chosen to represent the pathways of exposure to potential aquatic receptors, a high level of sensitivity for the respective test media, and comparability with the RWQCB Bay Protection and Toxic Cleanup Program (BPTCP).

- Analytical tests were chosen to detect concentrations of contaminants expected in the HPA media of concern using approved methodologies to decrease analytical uncertainties. Sound analytical methods coupled with an effective sampling design will allow the data user to determine how the contamination is represented in the different media.

- The sample location design was created to detect, if present, a gradient of contamination from onshore to offshore using transects of varied length. An optimum number of stations were chosen along each transect to provide for the assessment of a contaminant gradient. In addition, other selected sites were chosen to supplement the knowledge of offshore contaminant levels at known or suspected sites.

- Many of the proposed sampling techniques are based on tried and approved methods used in the Puget Sound Estuary Program developed under the State of Washington and Federal EPA auspices.

3. **Comment:** **Section 3.6: Comparability. The statement that levels of precision, accuracy and completeness are listed in Appendix A is inaccurate; only precision and accuracy objectives are included. This statement or the Appendix should be edited for consistency.**

Response: The word "completeness" has been deleted from the second paragraph in Section 3.6.

4a. **Comment:** **Section 4.0: Sampling Procedures. Several items related to Tables 1, 2, 4 and 5 need to be clarified or edited.**

A. Table 1: Analytical Methods. Table 1 includes only the chemical analyses. The bioassays should either be included in this table or in a separate table (1B).

Response: Bioassay information has been included in Table 1.

4b. **Comment:** **B. Table 2: Sample Container, Holding time and Preservative Requirements for Sediment Samples, Ammonia. It is not clear whether the sediment should be chilled and preserved for up to 28 days, chilled or preserved and kept at another temperature, or chilled and preserved prior to analysis. The treatment of the sediment for the analysis of ammonia may need to be clarified in a Standard Operating Procedure.**

Response: The EPA protocol (EPA Method 350.1) requires that the sample be preserved "by addition of 2 mL conc. H_2SO_4 per liter and refrigeration at 4°C." The sample is preserved and refrigerated until analyzed before 28 days has expired. A SOP for ammonia is not necessary. Table 2 has been modified to clarify this procedure.

4c. **Comment:** **C. Table 4: Sample Container, Holding Time and Preservative Requirements for Tissue Residue Analysis. In the Note b, which refers to Sample Containers "G", is defined as "Glass jars with room left for freezing water." The note is ambiguous as stated and should be rewritten to include the concept of leaving headspace in the jars to allow for expansion of water in the sample.**

Response: The statement has been modified as requested.

4d. **Comment:** **D. Table 5: Sample Container, Holding Time and Preservative Requirements for Sediment and Pore Water Bioassays. It is suggested that the echinoderm development test reference the most recent EPA protocol.**

Response: Table 5 has been modified as requested.

5a. **Comment:** **Section 8.0: Analytical Procedures and Reporting Limits. There are notes**

on several tables in this section that need clarification.

A. Table 11-14: Contract-Required Quantitation Limits (CRDL) All these tables contain notes referring to the California maximum concentration limits or maximum contaminant level (both sets of terms are used, presumably referring to the same numbers), but these are not referenced, nor are they discussed in the text. In the Bay Protection and Toxic Cleanup Program QAPP, prepared by the State Water Resources Control Board (July 1994), the detection limits for other analytes than those noted are lower than those listed in these tables. A discussion of the apparent discrepancy should be included in this section.

Response: With regards to the BPTCP QAPP and the detection limits noted in it, the Navy has the following comments and suggestions:

(1) While the BPTCP QAPP was helpful in its description of analytical techniques and laboratory standard procedures, it did not provide specific techniques nor did it recommend approved analytical methods to achieve the specified detection limits. On page 7 of Section 5, the following statements are found: "No single analytical method has been approved officially for low-level (i.e., low parts per billion) analysis of organic and inorganic contaminants in estuarine sediments and fish tissue" and "...laboratories are not required to use a single, standard analytical method for each type of analysis, but rather are free to choose from the best or most feasible method within the constraints of cost and equipment."

It is the Navy's intent to use officially approved methods (that is, EPA CLP) and apply approved modifications in order to achieve lower detection limits.

The Navy suggests the following as possible modifications for sediment and tissue matrices: (1) double the amount of sediment used for analysis, (2) decrease the final volume of extract, and (3) analyze initial calibration solutions at much lower concentrations than those prescribed in the EPA-approved methods. The first and second modifications proposed will be possible if the sediment or tissue matrix is relatively clean, free of contaminants of concern and interferences. The third modification will be instrument-dependent, since the laboratory will have to prove that the calibration curve is linear (with an acceptable relative standard deviation) using the new low calibration standard.

(2) It appears that the detection limits noted in the BPTCP QAPP are based on method detection limits (MDL), which are statistically based numbers. The detection limits noted in the QAPP for the phase 1B ecological risk assessment are quantitation detection limits based on the lowest concentration of the calibration standards, and taking into consideration the initial sample weight and the final volume of the extract.

Proposed Modifications

Volatile Organic Compounds: No modification for pore water will be necessary as the laboratory will already be using a modified 25-ml purge for pore waters and there is no effective modification known for sediment/tissue.

Semivolatiles Organic Compounds: Modification using "Superfund Analytical Methods for Low Concentration Water for Organic Analysis" (EPA 1992). This will result in two-fold improvement for most compounds in the pore water matrix. If the initial volume of sediment is doubled and the final volume of the extract is reduced to half, a two- to four-fold improvement may be achieved for sediment and tissue matrices, depending on whether both techniques can be implemented.

Pesticides and PCBs: Using "Superfund Analytical Methods for Low Concentration Water for Organic Analysis" (EPA 1992), a five-fold improvement in detection limit for pore waters may be achieved. If the initial volume of sediment is doubled and the final volume of the extract is reduced to half, a two- to four-fold improvement may be achieved for sediment and tissue matrices, depending on whether both techniques can be implemented.

Metals: The CRDL stated in Table 14 is the maximum detection limit for a specific metal. Laboratories report nondetected concentrations at the instrument detection limit (IDL) level, which is much lower than the CRDL.

Organotins: By switching to the National Oceanic and Atmospheric Administration (NOAA) method "A Method for Analysis of Butyltin Species and Measurement of Butyltins in Sediment and English Sole Livers from Puget Sound" (NOAA 1988), detection limits of 0.05 ug/L for pore water and 5 ug/kg for sediment/tissue may be achieved.

5b. **Comment:** **B. Table 14. The sediment and tissue CRDL column units are given as mg/kg, but the legend at the bottom of the table reads μm/kg. This inconsistency should be corrected.**

Response: The following footnote will be added: "mg/kg = milligram per kilogram."

5c. **Comment:** **C. Table 15: Miscellaneous Analyses CRDL. The units mg/kg should be written out in the legend.**

Response: The following footnote will be added: "mg/kg = milligrams per kilogram."

6. **Comment:** **Section 8.10.3: Echinoderm Development Test. The references for this test should be up-dated. The Chapman and Denton 1995 EPA protocol should be followed, as it is eliminates the several issues that are problematic in the current SOP, as discussed in item 10.**

Response: Section 8.10.3 has been modified to reflect the suggested changes.

7. **Comment:** **Section 9.1: Field Quality Control Samples. The need for temperature**

blanks should be discussed in this section.

Response: Temperature blanks are generally provided by the subcontracted laboratory, one temperature blank per cooler. The temperature blank consists of a 40-ml volatile organic analysis (VOA) vial half-filled with tap water and unpreserved. The purpose of the temperature blank is to monitor the temperature of samples at the time of arrival at the laboratory. This vial will be clearly labeled "TEMPERATURE" so it is not confused with a real environmental sample. If samples are received at a temperature greater than 5 °C, the laboratory issues a nonconformance. The laboratory will promptly inform the Navy's project chemist or assigned point of contact of the nonconformance. Alternatively, the subcontracted laboratory may not need to supply a temperature blank if an infrared thermometer is used to measure the temperature of received samples. Section 9.1.5, "Temperature Blanks," will be added to the QAPP.

8. **Comment:** **Section 9.1.1: Field Duplicate Samples. For consistency, the need to collect duplicate samples of pore water and tissue should be discussed in this section, as Table 16: Field Quality Control Samples includes these media as well as sediment.**

Response: EPA procedure requires field duplicates for water samples only. Pore water is not collected in the field but is extracted from sediment in the laboratory; therefore, a duplicate is not required. Tissue samples do not require a duplicate. Text will be added to the QAPP to state this clearly.

9. **Comment:** **Appendix D: Standard Operating Procedure (SOP) for Determination of Sediment Biological Oxygen Demand (BOD), Section 3.4: Analytical Procedures. It is not clear in the directions under the second bullet which of the two methods for determining BOD is recommended. In the third bulleted paragraph, the instructions refer to analysis of a <u>second</u> sample. In the present context, it should read <u>blank</u> sample.**

Response: Information had been left out of SOP and the specific parts of Section 3.4 have been modified to correct the omission.

10a. **Comment:** **Appendix E: SOP for 48- to 96-H Development Abnormality Toxicity Test with <u>Strongylocentrotus purpuratus.</u> Because there are several issues in the protocol as written that need clarification or modification, it is suggested that the 1995 EPA protocol be used in its place.**

Response: Appendix E will be modified to reflect the 1995 EPA protocol (Chapman and Denton 1995).

10b. **Comment:** **A. Section 6.0: Bioassay Procedure. The density of the inoculum, 2000 organisms/20mL test chamber seems very high. Densities on the order of 30 organisms/mL are more common for development tests in small volumes.**

Response: The EPA test protocol calls for 25 eggs per mL of test solution per chamber. The number of organisms per test chamber has been reduced.

10c. Comment: **B. Section 7.0: Daily Monitoring of the Tests. Taking water quality in a small test volume is difficult and may introduce contamination. A water quality blank should be made up for this purpose. Measuring ammonia at the end of the test is problematic because of the small total volume of test samples. Taking the ammonia concentration of the sample at the beginning of the test may be sufficient.**

Response: Temperature, pH, salinity, dissolved oxygen, and ammonia will be measured at the start of the test. The SOP will be modified to reflect this change.

10d. Comment: **C. Section 9.0: Test Completion. The directions in the second paragraph seem to require compositing the replicates before counting the larvae. This would mean that true replication would be lost. The replicates should not be mixed; each replicate should be counted separately.**

Response: The wording will be revised to indicate that the integrity of each sample should be preserved.

11. Comment: **Appendix H: SOP for Conducting Sediment Pore Water Toxicity Test with the Luminescent Bacteria Photobacterium phosphoreum, Section 5.3: Osmotic Adjustment. The sentence beginning "NaCl reacts minimally..." does not make sense as it is written and needs to be edited.**

Response: Section 5.3 of Appendix H has been revised for clarification and to incorporate new information.

12a. Comment: **Appendix I: SOP for Preparation of Tissue for Analysis.**

A. Section 2.3: Preparation of Tissue Samples. This section needs to be edited and should be expanded to include more specific instructions as to how to avoid sample contamination.

Response: Section 2.3 of Appendix I has been edited and revised.

12b. Comment: **B. Section 2.5: Tissue Preparation. There should be some discussion concerning how to avoid possible contamination of the sample as it is processed in a grinder.**

Response: Section 2.5 of Appendix I has been revised to address this issue.

3.3 CDFG COMMENTS

GENERAL COMMENTS

1. **Comment:** **The QAPP references several other pertinent documents, such as the field sampling plan (FSP) and the Phase 1B work plan (WP), stating that they are companion documents to this QAPP. Because the Department has not reviewed those document and is evaluating the QAPP as a stand-alone document, the reviewer was at a disadvantage to understand the specifics of the work to be performed, including the underlying scientific strategy that is intended to accomplish the goals of the project, and place that work in the context of the QAPP. It would be very helpful to provide a summary of each of these documents in the QAPP, either as an appendix or within the body of the QAPP. Many of our comments may therefore make suggestions or ask questions that are explained in documents separate from this QAPP, but we are unaware of the references in the other documents. While these documents are apparently available, we would still request that a summary of the FSP and the WP be provided in the QAPP. As it is, there is no way to know the type of sampling to be done, the frequency of sampling, location, depth, volume, media, and eventual disposition of the samples (e.g., homogenized for chemistry).**

Response: The original plan was to include the FSP and QAPP as appendices to the work plan. However, since the work plan and the QAPP are very large documents in themselves, it was decided to separate each of the three documents. The Navy intended for the reviewers to have access to all three documents. The intent of the Navy is for everyone involved in the project to have a copy of all three documents and therefore be able to refer to the appropriate document as necessary. The QAPP and FSP will be revised as necessary, and the changes will be redlined. However, the additional sections requested in the comment will not be included. All three documents will be submitted together in one binder which will have a copy of the response to comments included.

2. **Comment:** **The project description at the start of the QAPP should be expanded greatly to provide more specific information, for reasons given in the previous paragraph, regarding the goals and objectives of this project, to provide a description of the scientific approach being implemented, as well as the general rationale behind the scientific approach, and a brief summary of how the data will be analyzed and utilized for decision-making.**

Response: See the response to CDFG general comment No. 1, above.

3. **Comment:** **The sections pertaining to the chemical analyses to be performed were rather disjointed and confusing. In the final document, it would be helpful to include the precision and accuracy objectives contained in Appendix A in the main body of the report when discussing laboratory analytical procedures. Perhaps, again, more specific information is provided in other associated documents, such as the FSP or WP, but it would be helpful to provide a summary of any information on chemical analyses to be performed. Specific comments will be provided below on**

this topic. Not knowing the rationale behind the conducting of pore water chemical analyses (we assume it will be to associate toxicological effects), it is difficult again, to judge the adequacy of the method detection limits requested.

Response: The Navy will leave the precision and accuracy information in Appendix A. The description of chemical methods to be performed is contained in Section 8.0 of the QAPP. The use of pore water is discussed in the work plan, Sections 6.2.2, 7.1.2, and 7.1.3, and the extraction procedure is presented in Appendix F of the QAPP.

4. **Comment:** **The San Francisco Bay Regional Water Quality Control Board ("RWQCB"), in cooperation with the Department and the State Water Resources Control Board, conducted a research program on the establishment of sediment reference sites for toxicological analyses in San Francisco Bay. We strongly urge that you contact Ms. Karen Taberski of the RWQCB staff (510-286-1346) regarding this program, and incorporate findings from this program for selecting reference sites for your project, along with input and consultation with the Department. RWQCB is encouraging contractors conducting toxicological and chemical analyses in the Bay to utilize these sites, since they demonstrated consistency through time and with several different toxicity tests during the research program. Additionally, you should discuss with Ms. Taberski the effort to encourage standardization of such items as test duration of the urchin development test, and depth of sediment to sample for San Francisco Bay.**

Response: Ms. Taberski, RWQCB, has been contacted concerning the use of proposed reference stations in San Francisco Bay, and three of the proposed stations will be used in this study. The echinoderm test meets the testing duration that the RWQCB uses, and the sediment depth to be sampled follows the RWQCB guidance.

SPECIFIC COMMENTS

1. **Comment:** **Page 1, last paragraph: "This QAPP discusses field protocols for sample collection and handling, equipment decontamination,..." We were unable to locate these items in the document and they assisted our review by providing details essential to a QAPP. It is recommended that this information be included in the final document. This comment is similar to those general comments made above regarding the need to provide summaries of items which may appear in other documents, but which are very pertinent for inclusion in this QAPP for adequate review to be performed.**

Response: The field sample collection and handling, equipment decontamination, field documentation, and sample chain-of-custody are presented in the text of the

FSP. The intent of the Navy is for everyone involved in the project to have a copy of all three documents, and therefore be able to refer to the appropriate document as necessary.

2. **Comment:** **Page 2, first paragraph: This paragraph provides a brief text summary of protocols that will be followed for various analytical procedures. Again, it would be helpful if summary information had been provided on these procedures, as there are many opportunities for contract laboratories to alter protocols to improve performance which are of interest to those reviewing such work. Are performance-based methodologies for organic and inorganic constituent analyses going to be allowed? Will interlaboratory testing be performed? There are numerous options and choices to be made in following protocols that should have been described. Mention is made of fish tissue analysis. What fish tissue will be analyzed? There is no mention in this QAPP of the capture and subsequent analysis of fish for contaminants.**

Response: Page 7 of Section 5 of the BPTCP QAPP defines a "performance based" approach for quality assurance of low-level contaminant analyses as one that involves "a continuous laboratory evaluation through the use of accuracy-based materials (e.g., CRMs), laboratory fortified sample matrices, laboratory reagent blanks calibration standards, and laboratory and field duplicated blind samples, if authorized and funded." Based on that definition, all of the methodologies in the Hunters Point Annex phase 1B QAPP are performance-based. Interlaboratory testing will not be performed; however, perhaps the RWQCB could include the laboratory selected for this phase 1B work in their annual interlaboratory comparison, or provide the Navy with the names of the laboratories that have successfully and consistently demonstrated their capabilities. A split-sampling event is being coordinated between PRC and EPA as a form of interlaboratory testing. The whole fish will be analyzed, as wildlife does not differentiate among the parts of a fish when consuming it. Invertebrates will be collected for tissue analysis, and so will fish if a local species can be found.

3. **Comment:** **Page 10, Section 3.0 (Objectives for Measurement): The QAPP would be improved by provided a table containing a summary of measurement objectives for all analyses being performed (accuracy requirement, precision requirement, completeness goal). It would also be helpful seeing these topics further explained and summarized in the laboratory analytical section for the chemical analyses (the reviewer can examine the various requirements for a particular analysis in one cohesive section, rather than scattered throughout the QAPP).**

Response: See the response to CDFG general comment 3, above. The completeness goal is 90 percent and is an overall goal, rather than a method-by-method goal.

4. **Comment:** **Page 34, Section 8.0, paragraph one: "Other EPA and Navy-approved analytical methods may be selected, with approval from the Navy RPM, if**

existing DQO's are met or exceeded." We are glad to see this statement in this analytical procedures section, and fully encourage the utilization of performance-based methodology, including interlaboratory testing. We recommend consultations with Department scientists on selection of alternative analytical methodologies and schemes.

Response: Comment acknowledged.

5. **Comment:** **Tables 11, 12, 13, 14, 15: An explanation of the utility of the pore water analyses should have been provided in this QAPP, in order to be able to evaluate, and provide recommendations on the appropriateness of the detection limits listed in the referenced tables. While we fully encourage the utilization of pore water chemistry and toxicity testing in order to be able to evaluate potential ecological impacts, we would like to know the objectives of the Navy for conducting these analyses. The majority of the pore water detection limits presented in the QAPP are very high, so that mostly non-detects will result from the analyses. Other studies done from fairly similar areas in San Francisco Bay (i.e., ERA of Marine Sediments at United Heckathorn Superfund Site near Richmond, EPA 1994) have shown actual levels of many of the listed pore water analytes to be below most of the detection limits listed for this study. One major flaw in the use of liberal detection limits will be an inability to evaluate any toxicity effects. What would seem to be most relevant is the effects levels for toxicity testing, i.e., ecological relevance. The volumes of pore water prior to extraction appear to be more than enough to be able to utilize lower detection limits than listed, and we believe that lower limits can be achieved with little extra chemical effort. We recommend a re-examination of the detection limits selected and suggest that a discussion or explanation be provided, if it cannot be accomplished. Also, we assume that dissolved organic carbon content will be conducted on all pore water samples, but do not see reference to this in the QAPP. This should be included in the final QAPP document.**

Response: The use of pore water in this study may be found in sections 6.2.2, 7.1.2, and 7.1.3 of the work plan. The detection limits for pore water in Tables 11, 12, 13, 14, and 15 have been revised. Dissolved organic carbon analysis will be conducted on pore water.

6. **Comment:** **Page 51, Table 15: There are no detection limits listed for sulfide or ammonia in overlying water or pore water, which will be conducted for toxicity tests (we assume, based on the QAPP). Why is this? Also, we feel very strongly that hydrogen sulfide should be measured in all toxicity test chambers, in addition to ammonia.**

Response: The detection limits have been added to Table 15. Ammonia is being measured in the sediment, overlying water, and pore water of the toxicity tests. Hydrogen sulfide will not be analyzed, since it is not required by the bioassay protocols, but will be measured with the regular suite of analytical

tests for pore water.

7. **Comment:** **Page 53, Section 8.9: The text states "pore water will be analyzed for sulfides", yet there is no information pertaining to hydrogen sulfide analyses (detection limits, accuracy and precision requirements). Equally confusing, the text does not state that ammonia will be measured in pore water. Will ammonia be reported as total ammonia, unionized ammonia, or (preferably) both? Does the method for grain size analysis provide for just percent fines?**

Response: Precision and accuracy have not been determined for sulfides using method 376.1. Using method 376.2, precision has not been determined, but accuracy is about ± 10 percent. Ammonia will be reported as both total ammonia and unionized ammonia and will be measured in both the pore water and sediments. The method for grain size reports all fractions.

8. **Comment:** **Page 53, Section 8.10: Will ammonia and hydrogen sulfide be measured in pore water and overlying water in toxicity test chambers? How will the data be reported for these parameters (see above comment)? We would also urge, once again, the incorporation of the San Francisco Bay RWQCB's Reference Site Program's sampling locations for field sediment reference sites for your project. What range of grain size, hydrogen sulfide and ammonia are you trying to select against for the species and protocols of choice in this program? We recommend modification of the final QAPP to include these considerations.**

Response: Only ammonia will be measured in the overlying water and pore water in the bioassay tests. Ammonia will be reported as total and unionized. The Navy will utilize the reference stations proposed by the RWQCB for San Francisco Bay. The range in grain size, hydrogen sulfide, and ammonia tolerances will be incorporated into the respective bioassay protocols as appropriate.

9. **Comment:** **Page 57, Overlying Water Quality: Again, we strongly request the inclusion of the measurement of hydrogen sulfide in toxicity test chambers in overlying water (and pore water, too) for the amphipod test described. If this is planned to be done, the QAPP does not state this.**

Response: As stated above, hydrogen sulfide will not be measured in the amphipod bioassay since it is not in the protocol.

10. **Comment:** **Page 57, "Salinity, pH, and ammonia in the overlying water and sediment grain size must be within tolerance limits of *E. estuarius*." Again, we request the inclusion of hydrogen sulfide as a parameter, and we also must ask that a table be provided that clearly states the tolerance limits of the amphipod that are being utilized.**

Response: As stated above, hydrogen sulfide will not be measured in the amphipod bioassay. The grain size tolerance will be included in the test protocol.

11. **Comment:** **Page 59: "Statistical test used and results of analysis of the data". How will the toxicity test data be analyzed, and how will the analyses be interpreted (i.e., what level of amphipod survival will be deemed a cutoff for toxic/non-toxic)? This needs much more discussion, and we suspect, and hope, that it has been in other documents. Again, a summary of this information, if it is indeed in other documents, is very necessary here in the QAPP to understand how the data will be utilized and to be able to comment on the appropriateness of the chosen statistical analytical method, as well as the interpretation of what any resulting data means. This comment applies to all toxicity tests being conducted. Additionally, it applies to chemical analyses being conducted: what level of chemical contamination is "acceptable", what level is "contaminated"? All of these should have been discussed in this QAPP in order to more fully be able to properly provide comments on the overall project strategy.**

Response: The statistical tests that will be used for analysis of the data are provided in each bioassay protocol in the appendix of the QAPP. How the bioassay results will be interpreted for indication of toxicity is discussed in section 7.1.6 of the work plan.

12. **Comment:** **Page 60, test duration: "48 to 96 hours" is listed as the test duration; we highly recommend at least 72 hours as a minimum duration, and suggest that you incorporate the protocols adopted in the S.F. Bay RWQCB Reference Site Program for standardized test duration for the sea urchin development test.**

Response: The new test protocol developed by EPA this year (Chapman and Denton 1995) will be incorporated into Appendix E of the QAPP. The echinoderm test duration will be 72 $\pm$ 2 hours.

13. **Comment:** **Page 60: "Salinity and ammonia in the test solution (pore water) must be within tolerance limits of *S. purpuratus*." Again, we request the inclusion of hydrogen sulfide as a parameter; and we also must ask that a table be provided that clearly states the tolerance limits of the urchin larvae that are being utilized.**

Response: The tolerance limits for the sea urchin to ammonia (if available) and salinity will be included. However, hydrogen sulfide will not be analyzed because it is not required in the protocol.

14. **Comment:** **Page 62, "Statistical test used and results of analysis of data": Please see comment on same topic from page 59, above.**

Response: Please see the response to CDFG specific comment No. 11, above.

15. **Comment:** **Section 9.3: It is unclear what constitutes a matrix spike. What percent of analytes within a class of compounds are being required for this? At what level will you be doing spike enrichments (10x, 100x...)? Is there**

any reason why SRM's (or CRM's) are not being conducted for this project?

Response: A matrix spike is a laboratory quality control sample where a defined amount of a target analyte(s) is added to the matrix being studied (usually an extra quantity of the environmental matrix is given to the laboratory for analysis). The matrix plus the added target analytes and the matrix without any added target analytes are subjected to the analytical process (extraction or purging followed by instrumental analysis) and a percent recovery is determined. In general, the concentration of the added target analytes is at 5 to 10 times the detection limit. For volatile organic compounds, semivolatile organic compounds and pesticides/PCBs, the percentage of analytes in the matrix spike is approximately 20 percent of the total class of compounds.

Certified reference materials (CRM) will be used for both calibration and fortification of matrices. The Navy requires the use of different sources for calibration and fortification, and that at least one of the two standards be certified by the American Association for Laboratory Accreditation (AALA).

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REVISED FIGURES FROM WORK PLAN

STF-WEB3.DWG - 09/01/95 - CFR - 044-0254R11BWP

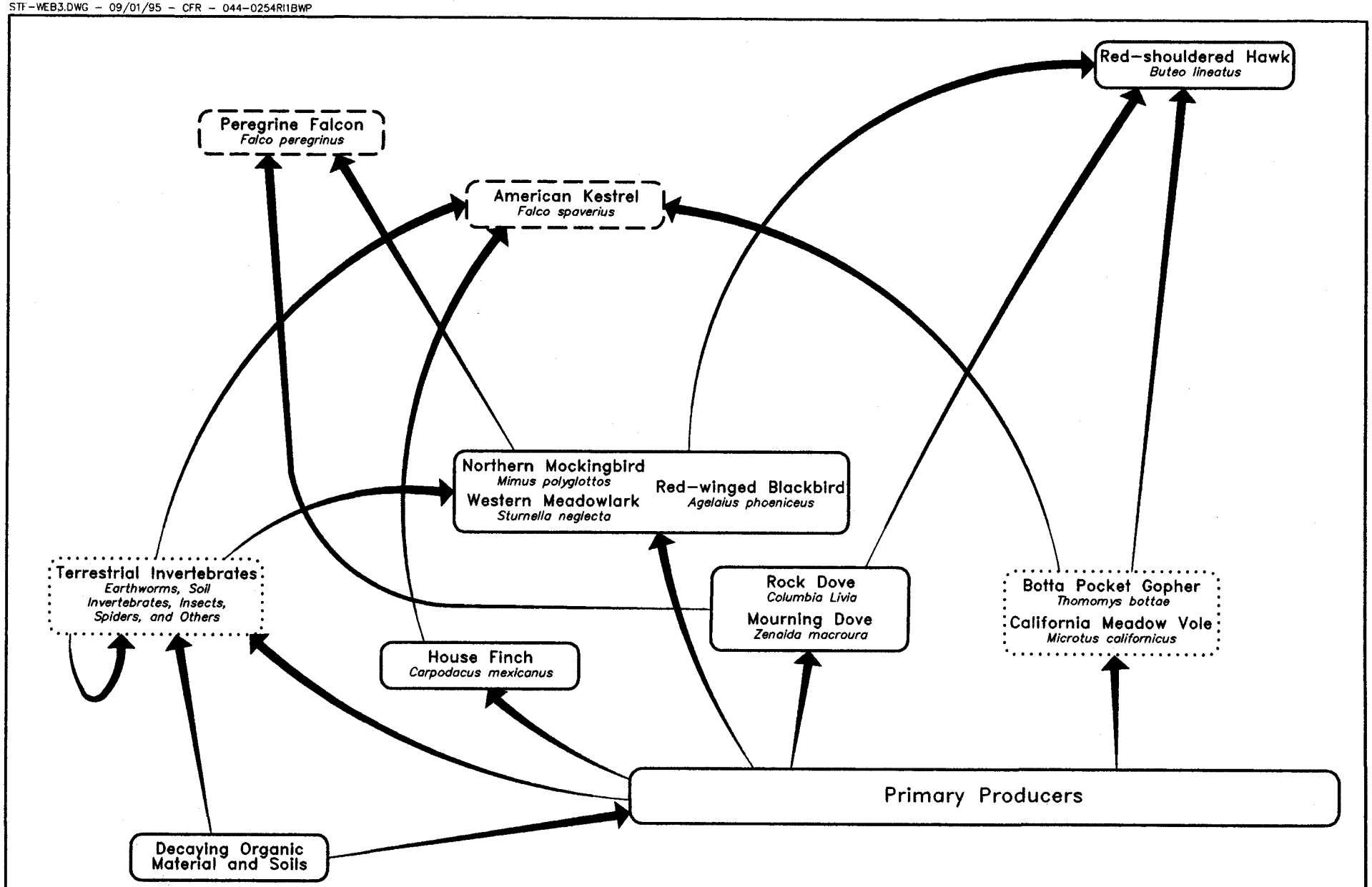
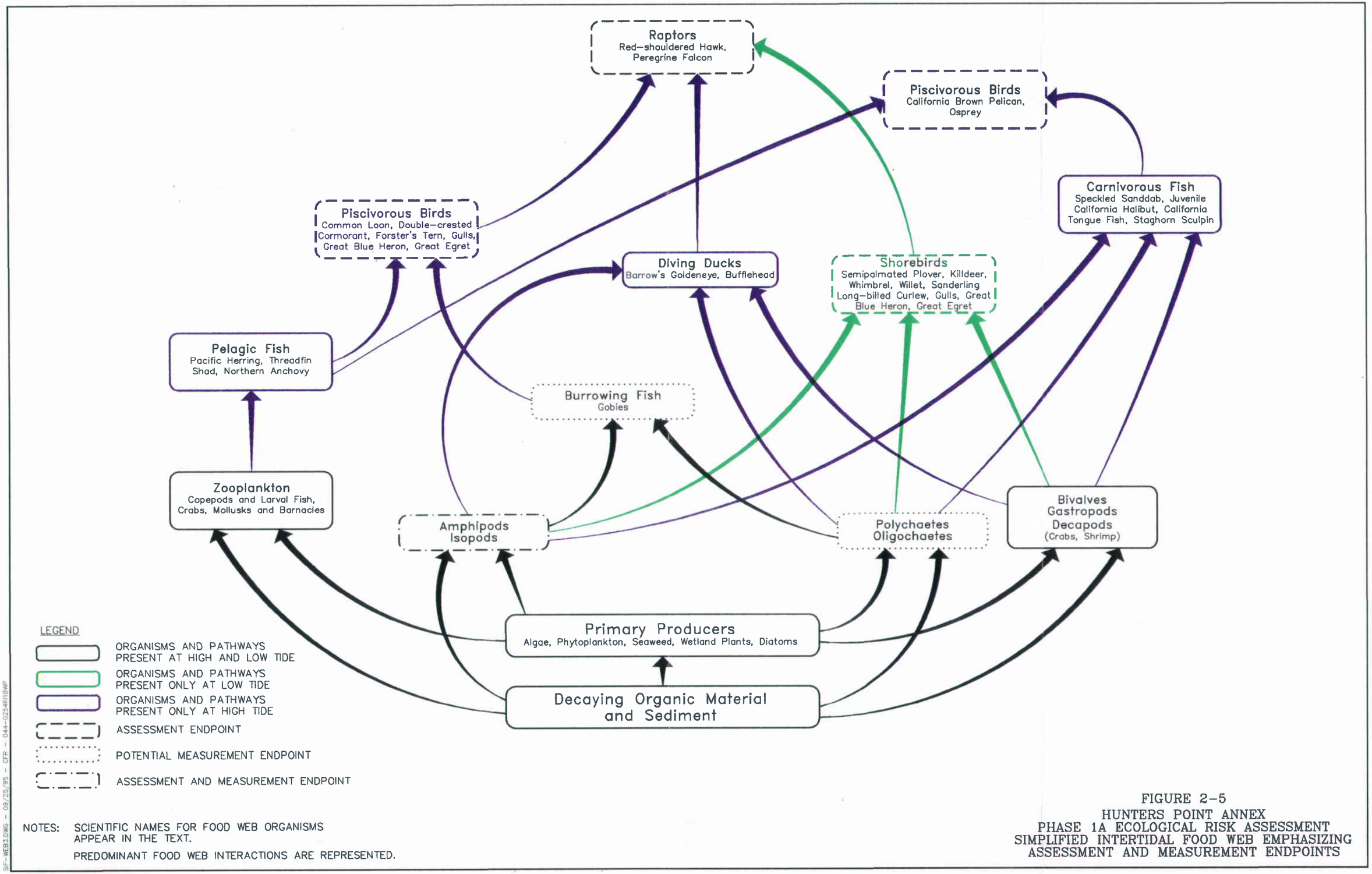


FIGURE 2-4
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
SIMPLIFIED TERRESTRIAL FOOD WEB EMPHASIZING
ASSESSMENT AND MEASUREMENT ENDPOINTS



NOTES: SCIENTIFIC NAMES FOR FOOD WEB ORGANISMS APPEAR IN THE TEXT.

PREDOMINANT FOOD WEB INTERACTIONS ARE REPRESENTED.

FIGURE 2-5
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
SIMPLIFIED INTERTIDAL FOOD WEB EMPHASIZING ASSESSMENT AND MEASUREMENT ENDPOINTS

SF-WEB3.DWG - 09/25/95 - CFR - 044-0254R1BWP

STATION 01 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.3	ug/kg	2	20	1.15	0.12
4,4'-DDE	2.4	ug/kg	2.2	27	1.09	0.09
Arsenic	5.6	mg/kg	8.2	70	0.68	0.08
Chromium	74	mg/kg	81	370	0.91	0.20
Copper	45.9	mg/kg	34	270	1.35	0.17
Dieldrin	6.2	ug/kg	0.02	8	310.00	0.78
Endrin	2.2	ug/kg	0.02	45	110.00	0.05
Fluoranthene	510	ug/kg	600	5100	0.85	0.10
Lead	23.6	mg/kg	46.7	218	0.51	0.11
Mercury	0.26	mg/kg	0.15	0.71	1.73	0.37
Nickel	72.8	mg/kg	20.9	51.6	3.48	1.41
Pyrene	600	ug/kg	665	2600	0.90	0.23
Zinc	107	mg/kg	150	410	0.71	0.26
HAZARD INDEX					433.37	3.97

STATION 01 - SUBSURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	5.5	ug/kg	2	20	2.75	0.28
4,4'-DDE	6	ug/kg	2.2	27	2.73	0.22
Arsenic	4.6	mg/kg	8.2	70	0.56	0.07
Chromium	93.5	mg/kg	81	370	1.15	0.25
Copper	58.2	mg/kg	34	270	1.71	0.22
Dieldrin	12	ug/kg	0.02	8	600.00	1.50
Endrin	4.8	ug/kg	0.02	45	240.00	0.11
Lead	27.2	mg/kg	46.7	218	0.58	0.12
Mercury	0.29	mg/kg	0.15	0.71	1.93	0.41
Nickel	96.5	mg/kg	20.9	51.6	4.62	1.87
Pyrene	680	ug/kg	665	2600	1.02	0.26
Zinc	140	mg/kg	150	410	0.93	0.34
HAZARD INDEX					857.99	5.64

STATION 02 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	4.2	ug/kg	2	20	2.10	0.21
4,4'-DDE	3.7	ug/kg	2.2	27	1.68	0.14
4,4'-DDT	9	ug/kg	1.58	46.1	5.70	0.20
Arsenic	3.6	mg/kg	8.2	70	0.44	0.05
Chromium	77.3	mg/kg	81	370	0.95	0.21
Copper	44.6	mg/kg	34	270	1.31	0.17
Dieldrin	7	ug/kg	0.02	8	350.00	0.88
Fluoranthene	440	ug/kg	600	5100	0.73	0.09
Lead	20.6	mg/kg	46.7	218	0.44	0.09
Mercury	0.32	mg/kg	0.15	0.71	2.13	0.45
Nickel	77.9	mg/kg	20.9	51.6	3.73	1.51
Pyrene	570	ug/kg	665	2600	0.86	0.22
Zinc	117	mg/kg	150	410	0.78	0.29
HAZARD INDEX					370.85	4.49

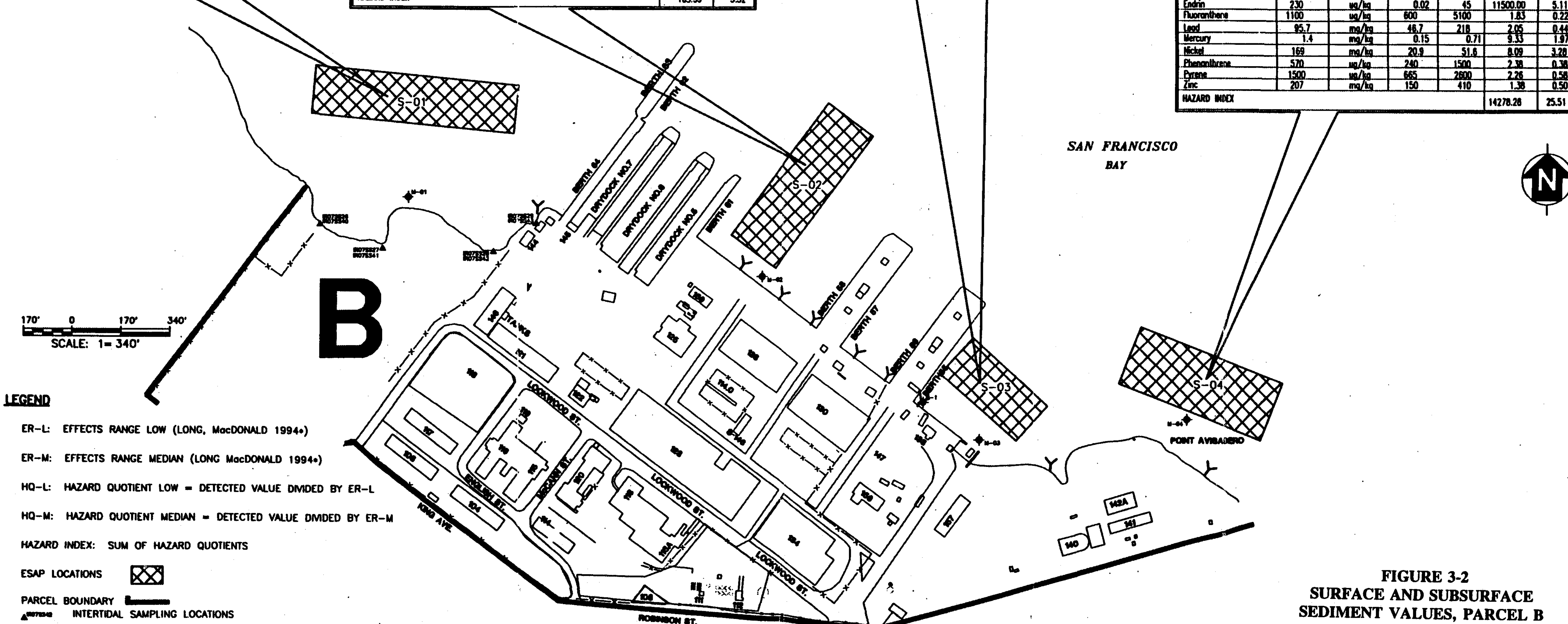
STATION 02 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.5	ug/kg	2	20	1.25	0.13
4,4'-DDE	3.5	ug/kg	2.2	27	1.59	0.13
Arsenic	4.4	mg/kg	8.2	70	0.54	0.06
Chromium	85.9	mg/kg	81	370	1.06	0.23
Copper	52.1	mg/kg	34	270	1.53	0.19
Endrin	3	ug/kg	0.02	45	150.00	0.07
Lead	24.2	mg/kg	46.7	218	0.52	0.11
Mercury	0.28	mg/kg	0.15	0.71	1.87	0.39
Nickel	88.3	mg/kg	20.9	51.6	4.22	1.71
Zinc	122	mg/kg	150	410	0.81	0.30
HAZARD INDEX					163.39	3.32

STATION 03 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	2.6	ug/kg	2.2	27	1.18	0.10
Arsenic	7.2	mg/kg	8.2	70	0.88	0.10
Chromium	71.7	mg/kg	81	370	0.89	0.19
Copper	42.1	mg/kg	34	270	1.24	0.16
Endrin	1.8	ug/kg	0.02	45	90.00	0.04
Lead	23.1	mg/kg	46.7	218	0.49	0.11
Mercury	0.26	mg/kg	0.15	0.71	1.73	0.37
Nickel	73.2	mg/kg	20.9	51.6	3.50	1.42
Zinc	103	mg/kg	150	410	0.69	0.25
HAZARD INDEX					100.60	2.73

STATION 03 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	19	ug/kg	2	20	9.50	0.95
4,4'-DDE	4.9	ug/kg	2.2	27	2.23	0.18
Arsenic	3.3	mg/kg	8.2	70	0.40	0.05
Chromium	83.9	mg/kg	81	370	1.04	0.23
Copper	53.7	mg/kg	34	270	1.58	0.20
Endrin	8	ug/kg	0.02	45	400.00	0.18
Lead	23.2	mg/kg	46.7	218	0.50	0.11
Mercury	0.3	mg/kg	0.15	0.71	2.00	0.42
Nickel	79.5	mg/kg	20.9	51.6	3.80	1.54
Pyrene	610	ug/kg	665	2600	0.92	0.23
Zinc	159	mg/kg	150	410	1.06	0.39
HAZARD INDEX					423.02	4.47

STATION 04 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	32	ug/kg	2	20	16.00	1.60
Arsenic	65.4	mg/kg	8.2	70	7.98	0.93
Benzo(a)anthracene	340	ug/kg	261	1600	1.30	0.21
Benzo(a)pyrene	340	ug/kg	430	1600	0.79	0.21
Chromium	133	mg/kg	400	2800	0.33	0.05
Chrysene	460	ug/kg	400	2800	1.13	0.16
Copper	851	mg/kg	34	270	3.15	25.01
Dieldrin	56	ug/kg	0.02	8	2800.00	7.00
Endrin	100	ug/kg	0.02	45	5000.00	2.22
Fluoranthene	920	ug/kg	600	5100	1.53	0.18
Lead	157	mg/kg	46.7	218	3.36	0.72
Mercury	5.6	mg/kg	0.15	0.71	37.33	7.89
Nickel	113	mg/kg	20.9	51.6	5.41	2.19
Phenanthrene	650	ug/kg	240	1500	2.71	0.43
Pyrene	1200	ug/kg	665	2600	1.80	0.46
Zinc	267	mg/kg	150	410	1.78	0.65
HAZARD INDEX					7906.51	28.06

STATION 04 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	47	ug/mg	2	20	23.50	2.35
Arsenic	5.7	mg/kg	8.2	70	0.70	0.08
Benzo(a)anthracene	430	ug/kg	261	1600	1.65	0.27
Benzo(a)pyrene	730	ug/kg	430	1600	1.70	0.46
Chromium	133	mg/kg	81	370	1.64	0.36
Chrysene	550	ug/kg	400	2800	1.38	0.20
Copper	694	mg/kg	34	270	20.41	2.57
Dieldrin	54	ug/kg	0.02	8	2700.00	6.75
Endrin	230	ug/kg	0.02	45	11500.00	5.11
Fluoranthene	1100	ug/kg	600	5100	1.83	0.22
Lead	95.7	mg/kg	46.7	218	2.05	0.44
Mercury	1.4	mg/kg	0.15	0.71	9.33	1.97
Nickel	169	mg/kg	20.9	51.6	8.09	3.28
Phenanthrene	570	ug/kg	240	1500	2.38	0.38
Pyrene	1500	ug/kg	665	2600	2.26	0.58
Zinc	207	mg/kg	150	410	1.38	0.50
HAZARD INDEX					14278.28	25.51



LEGEND

ER-L: EFFECTS RANGE LOW (LONG, MacDONALD 1994•)

ER-M: EFFECTS RANGE MEDIAN (LONG MacDONALD 1994•)

HQ-L: HAZARD QUOTIENT LOW = DETECTED VALUE DIVIDED BY ER-L

HQ-M: HAZARD QUOTIENT MEDIAN = DETECTED VALUE DIVIDED BY ER-M

HAZARD INDEX: SUM OF HAZARD QUOTIENTS

ESAP LOCATIONS

PARCEL BOUNDARY

INTERTIDAL SAMPLING LOCATIONS

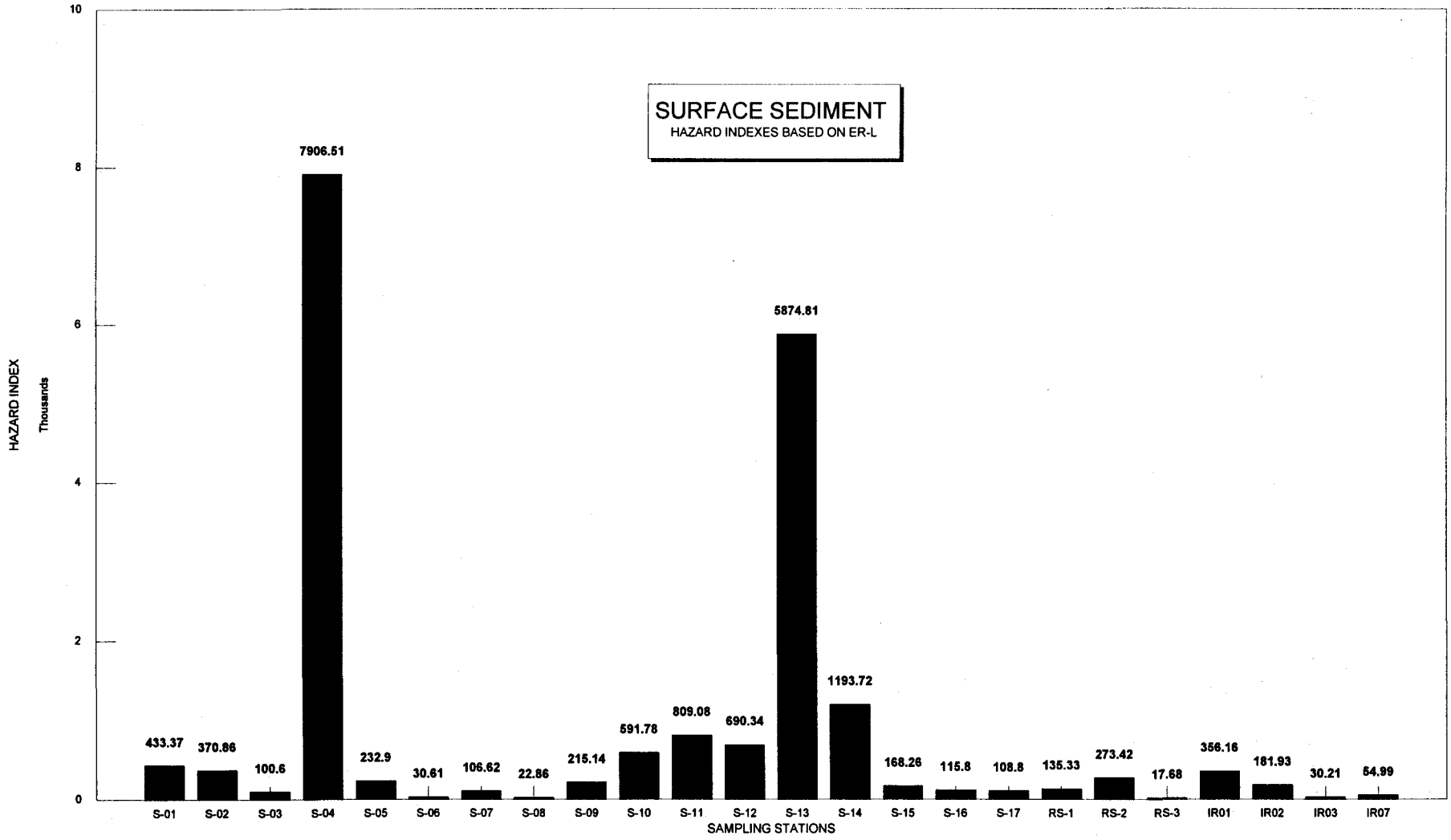
• VALUES FOR 4,4' -DDD, chrysene, dieldrin and endrin (NOAA 1991)

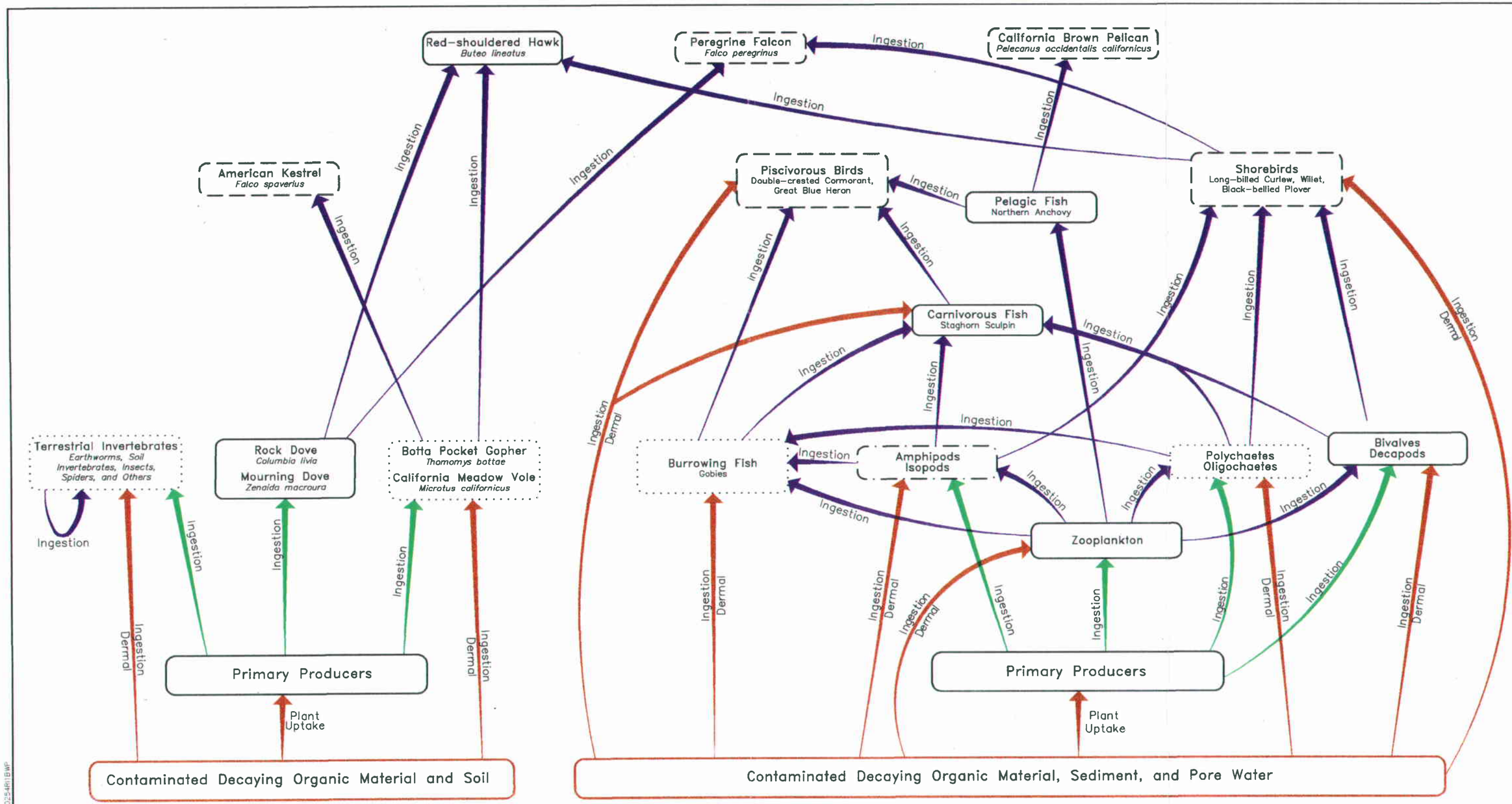
FIGURE 3-2
SURFACE AND SUBSURFACE SEDIMENT VALUES, PARCEL B

WTL(SF)X(044-0254)HP-ESAP1DWG - 08/27/04 - PLOT=337.5 REV.0001

FIGURE 3-7

SURFACE SEDIMENT
HAZARD INDEX BASED ON ER-L

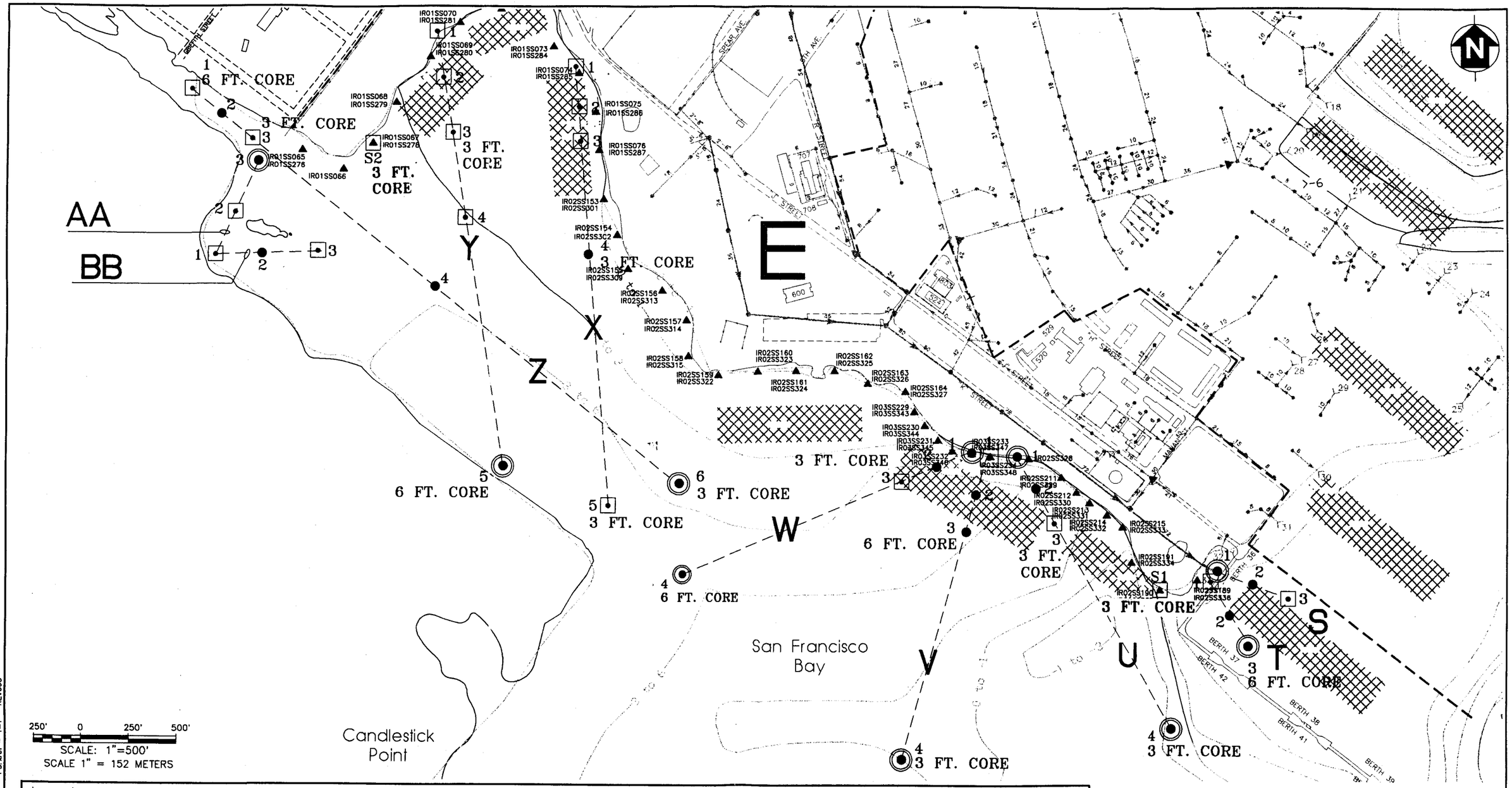




CTI-MEB3.DWG - 09/25/95 - CFR - 044-0254R1BWP

FIGURE 4-5

HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
CONTAMINANT EXPOSURE AND FLOW DIAGRAM
FOR EMPHASIZING TERRESTRIAL AND AQUATIC
ASSESSMENT AND MEASUREMENT ENDPOINTS



Legend

- STORM DRAIN, MANHOLE, FLOW ARROW, PIPE DIA., & OUTFALL
- ESAP SAMPLING LOCATIONS
- ▲ INTERTIDAL SAMPLING LOCATION
- TRANSECT
- FACILITY PARCEL BOUNDARY
- FACILITY BOUNDARY
- SEDIMENT DEPOSITION AND EROSION CONTOURS

- ● SURFACE SAMPLE–ANALYSIS:
  1. BULK CHEMISTRY
  2. AVS / SEM
  3. GRAIN SIZE
  4. TOTAL ORGANIC CARBON
  5. PORE WATER CHEMISTRY
- ⊡ AMPHIPOD / ECHINODERM / MICROTOX SURFACE SAMPLE–ANALYSIS
  1. SAME AS MICROTOX
  2. 10 DAY AMPHIPOD WHOLE SEDIMENT
  3. ECHINODERM DEVELOPMENT TEST
- ⊙ MICROTOX BIOASSAY SURFACE SAMPLE–ANALYSIS
  1. MICROTOX BIOASSAY
  2. AVS / SEM
  3. GRAIN SIZE
  4. TOTAL ORGANIC CARBON
  5. BULK CHEMISTRY
  6. PORE WATER CHEMISTRY

1 = STATION 0M FROM START OF TRANSECT
2 = STATION 60M FROM START OF TRANSECT
3 = STATION 120M FROM START OF TRANSECT
4 = STATION 500M FROM START OF TRANSECT
5 = STATION 700M FROM START OF TRANSECT
6 = STATION 1000M FROM START OF TRANSECT

HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

FIGURE 6–4
SEDIMENT SAMPLE LOCATIONS OFFSHORE OF PARCEL E

PRC ENVIRONMENTAL MANAGEMENT, INC.

KCH(SF)(044-0254)TRAN-E.DWG - 09/21/95 - PS.xref - 1=1 - REV003

REVISED TABLE FROM WORK PLAN

TABLE 3-6

SIGNIFICANT CHEMICALS CONTRIBUTING TO THE CONTAMINANT LOAD FOR SURFACE SEDIMENTS

Station	Chemical (Based on HI-L)	% of HI-L	Chemical (Based on HI-M)	% of HI-M
S-01	Dieldrin Endrin	71.53 25.38	Dieldrin Nickel	19.60 35.67
S-02	Dieldrin	95.33	Dieldrin Nickel Mercury	29.37 50.68 15.13
S-03	Endrin	89.46	Mercury Nickel	13.41 51.95
S-04	Endrin Dieldrin	63.24 35.41	Copper Dieldrin Mercury	11.23 24.94 28.10
S-05	Endrin	94.46	Mercury Nickel	14.64 49.30
S-06	4,4'-DDT Mercury Nickel	26.88 23.96 11.38	Nickel Mercury	26.90 29.54
S-07	Endrin	79.72	Nickel	26.67
S-08	Phenanthrene Nickel Pyrene Benzo(a)Anthracene	12.03 15.32 9.87 8.88	Pyrene Benzo(a)Anthracene	28.97 11.97
S-09	Endrin Dieldrin	39.83 58.29	Dieldrin Nickel	29.68 36.73
S-10	Endrin Dieldrin	38.02 58.30	Mercury Dieldrin Nickel	10.28 17.01 31.65
S-11	Endrin Dieldrin	52.84 44.76	Dieldrin Mercury Nickel	24.73 25.93 53.79
S-12	Dieldrin	94.16	Mercury 4,4'-DDD Dieldrin Nickel	10.88 13.08 20.24 24.86
S-13	Endrin Dieldrin	34.04 64.68	Dieldrin	51.62
S-14	Endrin Dieldrin	46.07 41.89	Silver Nickel Fluorene	10.70 12.95 23.52
S-15	Endrin	89.15	Mercury Lead Nickel	10.91 27.50 35.07

REVISED PAGE FROM APPENDIX A OF WORK PLAN

ESAP STATIONS - PARCEL B SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	% of HI-L	%of HI-M
S-04	Aldrin	22	ug/kg	Parcel B	---	---	---	---	---	---
S-04	alpha-Chlordane	68	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Aluminum	18200	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Aroclor-1260	2400	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Barium	85.6	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Benzo(b)fluoranthene	490	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Benzo(g,h,i)perylene	410	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Benzo(k)fluoranthene	550	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Bis(2-ethylhexyl)phthalate	700	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Chrysene	460	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Copper	851	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Dibutyltin	250	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Indeno(1,2,3-cd)pyrene	360	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Iron	33900	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Magnesium	16600	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Manganese	422	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Monobutyltin	10	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Potassium	3190	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Sodium	11300	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Tributyltin	1100	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Vanadium	54.9	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Chromium	133	mg/kg	Parcel B	400.00	2800.00	0.33	0.05	0.00%	0.17%
S-04	Copper	851	mg/kg	Parcel B	34.00	270.00	25.03	3.15	0.32%	11.23%
S-04	Chrysene	460	ug/kg	Parcel B	400.00	2800.00	1.15	0.16	0.01%	0.57%
S-04	Fluoranthene	920	ug/kg	Parcel B	600.00	5100.00	1.53	0.18	0.02%	0.64%
S-04	Benzo(a)pyrene	340	ug/kg	Parcel B	430.00	1600.00	0.79	0.21	0.01%	0.76%
S-04	Benzo(a)anthracene	340	ug/kg	Parcel B	261.00	1600.00	1.30	0.21	0.02%	0.76%
S-04	Phenanthrene	650	ug/kg	Parcel B	240.00	1500.00	2.71	0.43	0.03%	1.54%
S-04	Pyrene	1200	ug/kg	Parcel B	665.00	2600.00	1.80	0.46	0.02%	1.64%
S-04	Zinc	267	mg/kg	Parcel B	150.00	410.00	1.78	0.65	0.02%	2.32%
S-04	Lead	157	mg/kg	Parcel B	46.70	218.00	3.36	0.72	0.04%	2.57%
S-04	Arsenic	65.4	mg/kg	Parcel B	8.20	70.00	7.98	0.93	0.10%	3.33%
S-04	4,4'-DDD	32	ug/kg	Parcel B	2.00	20.00	16.00	1.60	0.20%	5.70%
S-04	Nickel	113	mg/kg	Parcel B	20.90	51.60	5.41	2.19	0.07%	7.80%
S-04	Endrin	100	ug/kg	Parcel B	0.02	45.00	5000.00	2.22	63.24%	7.92%
S-04	Dieldrin	56	ug/kg	Parcel B	0.02	8.00	2800.00	7.00	35.41%	24.94%
S-04	Mercury	5.6	mg/kg	Parcel B	0.15	0.71	37.33	7.89	0.47%	28.10%
	HAZARD INDEX						**7906.51**	**28.06**		

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN I)
Northern and Central California, Nevada, and Utah
CONTRACT Number N62474-88-D-5086

Contract Task Order No. 0254

Prepared For

DEPARTMENT OF THE NAVY
Engineering Field Activity West
Naval Facilities Engineering Command
San Bruno, California

PHASE 1B ECOLOGICAL RISK ASSESSMENT FINAL WORK PLAN HUNTERS POINT ANNEX

September 27, 1995

Prepared By

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TABLES

ACRONYMS AND ABBREVIATIONS

AC	-	Area of Contamination
APE	-	Area of Potential Exposure
ATSDR	-	Agency for Toxic Substances and Disease Registry
ASTM	-	American Society for Testing and Materials
AVS	-	acid volatile sulfide
AWQC	-	Ambient Water Quality Criteria
bgs	-	Below ground surface
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	-	Comprehensive Long-Term Environmental Action Navy
COPC	-	Chemicals of Potential Concern
CTO	-	Contract Task Order
DERP	-	Defense Environmental Restoration Program
DTSC	-	California Department of Toxic Substances Control
ED	-	exposure duration
EPA	-	U.S. Environmental Protection Agency
ER-L	-	Effects Range - Low
ER-M	-	Effects Range - Median
ERA	-	Ecological Risk Assessment
ESAP	-	Environmental Sampling and Analyses
FSP	-	Field Sampling Plan
HI	-	Hazard Index
HI-L	-	Hazard index low (sum of HQ-L)
HI-M	-	Hazard index median (sum of HQ-M)
%HI-L	-	Chemical HQ-L divided by HI-L times 100
%HI-M	-	Chemical HQ-M divided by HI-M times 100
HLA	-	Harding Lawson and Associates
HPA	-	Hunters Point Annex
HQ	-	Hazard Quotient
HQ-L	-	Hazard quotient low = detected value divided by ER-L
HQ-M	-	Hazard quotient median = detected value divided by ER-M
IR	-	Installation Restoration
IRP	-	Installation Restoration Program
LC_{50}	-	lethal concentration value

ACRONYMS AND ABBREVIATIONS
(Continued)

LD_{50}	-	lethal dosage value
NFA	-	No Further Action
LOAEL	-	lowest observed adverse effect level
LOEL	-	lowest observed effect level
NOAA	-	National Oceanic and Atmospheric Administration
NOAEL	-	no observed adverse effect level
NOEL	-	no observed effect level
OU	-	Operable Unit
PAH	-	polyaromatic hydrocarbons
PCB	-	polychlorinated biphenyls
PRC	-	PRC Environmental Management, Inc.
QA/QC	-	Quality Assurance/Quality Control
QAPP	-	Quality Assurance Project Plan
RI/FS	-	Remedial Investigation/Feasibility Study
RWQCB	-	California Regional Water Quality Control Board, San Francisco Region
SARA	-	Superfund Amendments and Reauthorization Act
SEM	-	simultaneously extracted metal
SFDA	-	San Francisco District Attorney's Office
SVOC	-	Semivolatile Organic Compounds
SUF	-	Site Use Factor
TOC	-	total organic carbon
TPH	-	Total Petroleum Hydrocarbons
TRV	-	Toxicological Reference Value
VOC	-	Volatile Organic Compounds

1.0 INTRODUCTION

The United States Navy is conducting an investigation to identify and evaluate hazardous waste sites at Engineering Field Activity West, Hunters Point Annex (HPA) under the Installation Restoration Program (IRP) of the Defense Environmental Restoration Program (DERP). The Navy has implemented a remedial investigation and feasibility study (RI/FS) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). PRC Environmental Management, Inc. (PRC) is providing technical support for RI/FS activities, including an assessment of ecological risks. The ecological risk assessment is being conducted under Contract Task Order (CTO) No. 0254 of Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-88-D-5086.

1.1 ECOLOGICAL RISK ASSESSMENT FRAMEWORK

The HPA ecological risk assessment (ERA) is being conducted in three phases: Phase 1A was a qualitative analysis; Phase 1B will result in the collection of quantitative measurements to determine risk, and if necessary, Phase II will follow to gather information needed for a feasibility study. During Phase 1A, existing site data were reviewed and biota were surveyed to more fully characterize the ecological community and to prepare conceptual site models of contaminant fate and transport and potential exposure by ecological receptors. The results of Phase 1A are being used to focus Phase 1B. This work plan summarizes the results of Phase 1A and presents the approach for filling data gaps and using quantitative measurements to assess the risk to ecological receptors during Phase 1B.

This phased approach is consistent with that recommended in U.S. Environmental Protection Agency (EPA) guidance (1989, 1992). The EPA framework (1992) consists of the following four basic steps.

1. **Problem Formulation:** Key factors to be considered in the ERA are compiled from previous investigation reports and existing data. These factors include the physical features, general distribution of contaminants, and the organisms likely to be found on site. A preliminary analysis identifies the objectives of the ERA, important regulatory issues, chemicals of potential concern, biological species, and endpoints to be considered in the assessment. This information is used to define the scope of the ERA and to determine the level of detail and information needed to complete the assessment.

2. **Exposure Assessment:** The ecological receptors (species and life stages) that are likely to contact the chemical stressors are identified, as are the likely exposure routes (for example, ingestion or dermal contact) and the spatial and temporal variation in exposure.

3. **Ecological Effects Assessment:** This step describes the potential adverse biological effects of exposure to stressors on organisms, and the relationship between the amount of exposure and these effects.

4. **Risk Characterization**: Information from the exposure assessment and the effects assessment is combined to evaluate the relationship between environmental concentrations of stressors and the probability of adverse biological effects. The degree of confidence in the risk estimate is evaluated by identifying important sources of uncertainty and the underlying assumptions used in the analysis.

Phase 1A led to development of a preliminary characterization of the site based on existing data, biotic surveys, and fate and transport analysis. Phase 1A corresponds to the problem formulation step of the EPA framework. Phase 1B will address gaps in site characterization data and identify specific methodologies that can be used for measuring exposure of and effects on ecological receptors at HPA. In this work plan, the results of Phase 1A (problem formulation) are summarized in Sections 2.0 through 4.0. The site location, climate, history, geology, hydrology, and ecology are described in Section 2.0. Section 3.0 contains an initial screening of existing data and a determination of contaminants of potential concern. Section 4.0 presents the development of the site conceptual models and describes assessment and measurement endpoints to be evaluated.

Phase 1B will provide additional information needed to describe the nature and extent of contamination in offshore sediments from HPA sources. The objectives of Phase 1B are presented in Section 5.0. Section 6.0 describes the methods that will be used to determine the distribution and nature of contamination in offshore sediments including the possible connections between onshore sources and the bay through groundwater transport. Section 7.0 presents the direct toxicity and tissue residue measurements that will be used to determine the toxicity of the sediments.

The remainder of this work plan describes the technical approach to be used to evaluate risks to ecological receptors at HPA. Risks to receptors in offshore sediments will be evaluated using toxicity tests and correlating the results with sediment chemistry and physical properties as discussed in Section 8.0. Risks to onshore receptors will be evaluated using existing tissue accumulation studies and modeling. Transport through the food webs and exposure to higher trophic receptors will be

evaluated using exposure models in comparison with benchmark effects concentrations as discussed in Section 9.0.

1.2 MODIFICATIONS TO DRAFT PHASE 1B WORK PLAN

Based on ongoing discussions with the regulatory agencies and natural resource trustees, some activities listed in the draft Phase IB work plan (PRC 1994h) will not be conducted, or the original approach will be altered. The main modifications to the draft Phase 1B work plan include the following:

- Use of the California halibut (*Paralichthys californicus*) as a benthic assessment endpoint has been eliminated because this species is highly mobile, ranges all over San Francisco Bay, and is not restricted to HPA property. The use of the loggerhead shrike (*Lanius ludovicianus*) as an avian assessment endpoint has been eliminated because its natural history is similar to the American kestrel (*Falco spaverius)*, which is also an assessment endpoint.

- The methodology for characterizing risk to benthic receptors has been changed significantly, as reflected in Section 8.0. Because of the multitude of chemicals in the sediment and the complexity of sediment toxicology, ecological risk to benthic receptors will be characterized using a semiquantitative, weight-of-evidence approach to evaluate the exposure and effects data. The risk assessment will include sediment chemistry measurements, sediment parameters that directly affect bioavailability, simple sediment toxicity models, and bioassays.

- Characterization of risk to aquatic avian receptors and terrestrial receptors has been modified, as reflected in Sections 8.0 and 9.0. The characterizations now include the steps that will be followed as well as explanations of the data to be compiled.

- A decision tree for determining risk to benthic receptors has been included as Figure 8-1.

- Originally a suite of six bioassays was proposed. This list has been decreased to three sediment bioassays: amphipod solid-phase sediment bioassay, pore water echinoderm larval development bioassay, and a pore water MICROTOX® using the marine bacterium, *Photobacterium phosphoreum* (Section 7.0).

- Tissue residue samples of invertebrates or fish (if a local species can be found) will be collected at 12 locations for use in the determination of dose for the avian receptors (Section 7.2.). These tissue samples may be supplemented with polychaete bioacumulation tests if enough biomass is not available for analysis at more than half of the stations.

2.0 SITE CHARACTERIZATION

In task 1 of Phase 1A, general information on the location, history, geology, hydrogeology, ecology, and other characteristics of HPA were compiled from previous investigations and reports. Important information on these topics is summarized in the following sections.

2.1 LOCATION AND CLIMATE

HPA is in southeast San Francisco, just north of Candlestick Park and approximately 8 miles north of the San Francisco airport. The facility lies on the southern tip of the Hunters Point Peninsula, which extends eastward into San Francisco Bay. The facility (Figure 2-1) is bordered on the north, east, and south by San Francisco Bay, and to the west by the Hunters Point District, which consists of public and private housing and commercial and industrial buildings. The northern and eastern shores of HPA are developed with drydock and berthing facilities for ship repair. The southern shore is undeveloped and consists mainly of fill. The property encompasses about 955 acres: 522 on land, and 433 under water (below the high tide line). Approximately 400 acres of the underwater property is subtidal (below the low tide mark); the remaining 33 are intertidal mudflats (between the low and high tide mark) (PRC 1994a).

The climate at HPA is characterized by partly cloudy, cool summers with little precipitation, and mild winters with intermittent rain. Meteorological data from San Francisco airport indicate that the prevailing wind is from the west-northwest. Typical conditions at HPA include prevailing westerly or northwesterly winds in late spring, summer, and early autumn, and more variable winds in winter. The winter wind pattern is influenced by storms that track to the south, resulting in winds from the east or southeast (USGS 1990, PRC 1994a).

2.2 FACILITY OPERATIONS AND SITE HISTORY

HPA was operated as a commercial drydock from 1869 until December 19, 1939, when the property was purchased by the Navy. The Navy leased the facility to Bethlehem Steel Company until December 18, 1941, when the Navy took possession and began operating the shipyard for the production of ships during World War II. Navy ships and submarines were also modified,

maintained, and repaired there. In addition, HPA was used for personnel training, limited radiological operations, research and development, and ship design. In 1974 the Navy ceased shipyard operations and placed the facility in industrial reserve. From May 1976 to June 1986 the Navy leased most of HPA to Triple A Machine Shop, which operated a commercial ship repair facility. Triple A subleased portions of HPA to private warehousing, industrial, and commercial firms. When the lease expired in 1986, Triple A refused the Navy's request to vacate HPA, forcing the Navy to initiate legal proceedings to resume possession. Following actions taken by the San Francisco District Attorney's Office (SFDA), Triple A vacated HPA in mid-1987. The SFDA also charged Triple A with illegally disposing of hazardous wastes such as waste oils, polychlorinated biphenyls (PCB), and solvents at about 20 locations throughout the facility (PRC 1994a).

Between 1986 and 1988, the Navy considered homeporting the battleship USS Missouri at HPA. A plan was developed and implemented during this period to characterize soil and groundwater contamination in parts of HPA as a prerequisite to development (ESA 1987). In 1989, HPA was placed on the National Priorities List (EPA 1990). The Navy thus implemented an RI/FS in accordance with CERCLA, as amended by SARA. For the RI/FS, HPA was divided into five operable units (OU) as defined in the Federal Facilities Agreement entered into on January 22, 1992, by the Navy, EPA, State of California Department of Toxic Substances Control (DTSC), and the State of California Regional Water Quality Control Board (RWQCB), San Francisco Region (PRC 1994a).

Recently the OU-based investigation was reorganized into a parcel-based investigation to accelerate the RI/FS, provide a framework for interim actions, and accelerate cleanup of contiguous sites for the purpose of reuse. Currently, five parcels onshore (A through E) have been formally defined (Figure 2-1). All offshore property is part of a sixth parcel, Parcel F. Table 2-1 summarizes the sites in each parce.

In 1990, the U.S. Department of Defense placed HPA on the base closure list, mandating that HPA be remediated and made available for nondefense use. HPA was designated a "B" site by the Agency for Toxic Substances and Disease Registry (ATSDR) in 1991, signifying that it poses no imminent threat to human health, but has the potential to pose a long-term threat to human health (PRC 1994a).

2.3 GEOLOGY AND HYDROGEOLOGY

The bedrock at Parcel A is at ground surface or less than 5 feet below ground surface (bgs) throughout much of the parcel. It is primarily Franciscan complex bedrock, generally consisting of serpentinite, with sandstone and shale bedrock and lesser amounts of chert and greenstone. Between 1935 and 1975, soils from the hillside on Parcel A and other fill materials were placed in San Francisco Bay, increasing the land area of the HPA facility from less than 100 to over 500 acres. Consequently, the subsurface stratigraphy at Parcels B, C, D, and E includes three artificial fill units: (1) serpentinite bedrock-derived fill consisting of gravel and boulder-sized material in a sand and/or clay matrix; (2) industrial fill; and (3) backfill material consisting of poorly graded sands and gravels. Generally, these fill materials overlay bay mud deposits and, to a lesser extent, undifferentiated sedimentary deposits (PRC 1994a).

Hydrogeological investigations (PRC 1994a) have identified three aquifers at HPA: the A-aquifer, the B-aquifer, and the Bedrock aquifer. Parcel A is primarily underlain by the Bedrock aquifer, while Parcels B through E are primarily underlain by the A-aquifer. Groundwater in the Bedrock aquifer generally flows outward from the topographic high of Parcel A toward the low-lying areas and out to San Francisco Bay. On the south-facing cut slope of Parcel A, a few small seeps and springs are perennial, while on the northeast slope a few intermittent seeps have developed in the Bedrock aquifer (PRC 1994a).

The A-aquifer, the most thoroughly characterized, consists of saturated porous media such as fill materials and undifferentiated upper sand deposits overlying bay mud deposits. Groundwater in this aquifer ranges from 2 to 15 feet bgs. The A-aquifer is recharged by precipitation infiltration in the unpaved area (especially within Parcel E), bay water intrusion, leakage from storm drains, and in some areas, sanitary sewer systems (PRC 1994a).

General trends of groundwater flow for HPA are shown in Figure 2-2. Groundwater flow in the A-aquifer at HPA is complex because the hydraulic properties of the subsurface fill materials are nonuniform and because of tidal influences, effects of storm drain and sanitary sewer systems, and variations in topography and drainage. Groundwater in the A-aquifer generally flows outward toward San Francisco Bay, except where reversed by the influence of Pump Station A and along the shoreline

where tidal influences are apparent. A relatively narrow horizontal zone (100 to 400 feet inland from the shoreline) of the A-aquifer is influenced by the fluctuations of tides in San Francisco Bay, especially in Parcel E. These tidal influences are less pronounced in Parcels B, C, and D because of construction along the shoreline (PRC 1994a).

The A- and underlying B-aquifers are separated by bay mud deposits, ranging from 5 to 60 feet thick under most of the low-lying areas of HPA (Parcels B through E). Clay and silt, which make up the greatest portion of the bay mud deposits, act as a confining layer between the A- and B-aquifers. The B-aquifer consists of saturated, porous, undifferentiated sedimentary deposits underlying bay mud deposits and overlying the Franciscan complex bedrock in the lower elevations of HPA. The B-aquifer is generally a confined, porous-media aquifer where groundwater is under pressure. The source of recharge of the B-aquifer is generally unknown, but the Bedrock aquifer and the San Francisco Bay likely contribute to it. Groundwater in the B-aquifer at HPA generally flows outward toward San Francisco Bay (PRC 1994a).

The Bedrock aquifer lies in the upper weathered portions or deeper fractured portions of the Franciscan complex bedrock. The Bedrock aquifer appears to be in direct hydraulic communication with the A-aquifer where the A-aquifer directly overlies it, which occurs mainly in excavated areas adjacent to the 1935 shoreline. Groundwater within the bedrock is limited to the discrete fractures or shear zones and weathered portions. Hydrogeologic conditions in the Bedrock aquifer are not well known facility-wide. Recharge to the Bedrock aquifer likely is from precipitation, runoff, leakage from storm drains and sanitary sewers, and in some areas, the A-aquifer (PRC 1994a).

2.4 ECOLOGICAL CHARACTERISTICS

The ecology of HPA includes aquatic environments, limited terrestrial habitat, and transitional wetlands, all of which have been disturbed by human activities such as dredging, excavation, filling, and development (HLA 1991). The onshore and offshore environments of HPA are discussed below, followed by a discussion of the types of animals that may use the habitats found on HPA.

2.4.1 Onshore Environment

Terrestrial habitat is found principally in Parcels A, B, and E. The two remaining parcels, C and D, are almost entirely paved with only small pockets of vegetation that are not considered suitable habitat for animals. Parcels A and E are significantly less developed than the rest of the base. Parcel A contains areas of relatively dense tree and brush cover in addition to grassy open areas. Conditions for plant and animal habitation are more favorable in this parcel than in the other onshore parts of the base, where poorly developed soil horizons, low organic content, soil contamination, and shallow saline groundwater appear to limit the composition and abundance of the terrestrial vegetation community. Plant species in Parcels B and E are opportunistic weeds and herbaceous species adapted to arid conditions and poor soil quality. Only a limited number and low diversity of animal species have been seen to use the onshore areas of Parcel B compared to Parcels A and E. Although Parcel E supports few plant species, reptiles, birds, and mammals have been observed in this parcel.

2.4.1.1 Terrestrial Habitats

Four separate habitat types are present on the onshore portions of HPA: (1) ruderal; (2) non-native grassland; (3) landscaped; and (4) wetland (coastal salt marsh) (HLA 1991) (Figure 2-3). Typical plants and animals of the four habitat types are summarized in Table 2-2.

Terrestrial plants have been surveyed four times in the last 6 years at HPA. On April 30, 1989, botanists from the California Native Plant Society surveyed HPA, India Basin, and Islais Creek (Sigg 1994). In July 1991, the Navy performed a wetland delineation (WESTDIV 1991). In September 1991, Harding Lawson Associates (HLA) conducted a terrestrial survey and assembled preliminary maps and species lists (HLA 1991). In 1993, PRC conducted an additional survey to confirm and supplement the habitat delineations and biota lists (PRC 1994c). Plant species observed at HPA during these recent surveys are listed in Table 2-3, along with their status as native California species and their typical habitat requirements.

The ruderal habitat is the most prevalent on HPA. Parcels B and E consist primarily of ruderal habitat typified by paved and fenced areas, abandoned lots and structures, and other disturbed areas. Ruderal areas are dominated by colonizing plants such as sweet fennel (*Foeniculum vulgare*), black

mustard (*Brassica nigra*), and annual brome grasses (*Bromus* sp.) (HLA 1991).

The non-native grassland habitat is located on the steep slope on the south side of the abandoned housing area in Parcel A. Dominant plant species in this habitat include wild oats (*Avena fatua*), ripgut (*Bromus diandrus*), fescue (*Vulpia myuros*), and yellow-star thistle (*Centaurea solstitialis*) (EPA 1993a; HLA 1991). This habitat also contains a small area of dense shrubs including native coyote bush (*Baccharis pilularis*), blackberry (*Rubus* sp.), and photina (*Photina arbutifolia*) (EPA 1994a; PRC 1994c).

Landscaped areas are located throughout the abandoned housing and surrounding the former officer's club and various other buildings. This habitat is dominated by ornamental shrubs, trees, and non-native grasses. Mature eucalyptus and pines are found on a ridge west of the housing area, and a variety of ornamental trees are interspersed throughout the landscaped area.

Several small areas of salt marsh wetland habitat have been delineated at HPA: four within Parcel E and one in Parcel B. This habitat is typically present within the zone of tidal influence and contains plant species tolerant of estuarine environments, including pickleweed (*Salicornia virginica*), salt grass (*Distichlis spicata*), and sedge (*Cyperus laevigatus*) (HLA 1991; WESTDIV 1991; PRC 1994c).

Historical surveys of HPA indicate that 65 species of native California plants were present before 1958, but were not found in the more recent surveys (Howell and others 1958). It is not known whether these species were not found recently because of the season of the survey, or because of physical disturbances such as building construction and fill activities that have occurred as HPA was developed.

2.4.1.2 Terrestrial Biota

The landscaped and non-native grassland habitats of Parcel A are the most rich in number of plant species, and provide foraging, nesting, and roosting sites for various birds, possibly including threatened, endangered, or other species of concern. The landscaped areas and non-native grassland communities within Parcel A, the ruderal habitat throughout Parcel E, and some of Parcel B provide food for granivorous, omnivorous, and scavenging birds observed at HPA (HLA 1991; EPA 1994a;

PRC 1994c). Typical seed-eating birds found in these habitats include mourning doves (*Zenaida macroura*), house finches (*Carpodacus mexicanus*), savannah sparrow (*Passerculus sandwichensis*), and song sparrows (*Melospiza melodia*). Typical insectivorous birds include the western meadowlark (*Sturnella neglecta*), northern mockingbird (*Mimus polyglottos*), and black phoebe (*Sayornis nigricans*) (HLA 1991).

There are also numerous burrows in Parcels A and E, which are suspected to have been created by small mammals. Mammals commonly found in ruderal and non-native grassland habitats of California include California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), meadow vole (*Microtus californicus*), house mouse (*Mus musculus*), black-tailed hare (*Lepus californicus*), and red fox (*Vulpes vulpes*). Of these, the Botta's pocket gopher, black-tailed hare, and red fox have been observed at HPA (PRC 1994c). This habitat may also provide a home for the western fence lizard (*Sceloporus occidentalis*), the gopher snake (*Pituophis melanoleucus*), and garter snakes (HLA 1991; PRC 1994c).

The mammal, bird, and reptile species noted above are a potential prey base for predatory birds. Red-tailed hawk (*Buteo jamaicensis*), peregrine falcon (*Falco peregrinus*), American kestrel (*Falco sparverius*), and red-shouldered hawk (*Buteo lineatus*) have been observed perching or hunting over Parcels A and E (PRC 1994c). Small mammals, reptiles, and birds may also serve as prey for red fox (*Vulpes vulpes*), whose tracks have been seen within HPA (EPA 1994).

2.4.2 Offshore Environment

The offshore property surrounding HPA can be divided into three geographic areas as described below:

- India Basin: The north area consists of a small portion of India Basin that is bordered to the west by HPA property, to the south by the submarine base area (IR-7), and to the east by inactive submarine berthing slips. Available information indicates that this area has not been dredged.

- South Basin: This is a moderate-sized, shallow inlet lying between the southern shore of Parcel E and northern shore of Candlestick Point. Available information indicates that this area has not been dredged.

- Berthing slips: This area is the east-northeastern flank of the facility, extending from the inactive submarine berthing slips of Parcel B eastward and then southward to the slips and drydocks of Parcels C and D, terminating at the mouth of South Basin. This water is relatively deep because the drydocking and berthing facilities were periodically dredged from 1942 to 1986 in support of various shipyard activities.

The aquatic habitats of India Basin and South Basin include (1) intertidal zones, which frequently contain man-made materials such as building debris, pier pilings, dock embankments, and rip-rap; and (2) subtidal areas, which are composed of unconsolidated mud substrates. Sediment sampling data indicate that fine-grained sediments predominate around HPA (HLA 1993). India Basin is marginally isolated from the open waters of San Francisco Bay, while South Basin is substantially isolated from the open waters of the bay. Aquatic habitats near the berthing slips adjacent to the drydock and berthing facilities of Parcels B, C, and D consist primarily of pelagic (open-water) areas influenced by San Francisco Bay. Parcel B has a small intertidal and subtidal zone in addition to the pelagic area.

2.4.2.1 Aquatic Biota

In addition to the wetland habitat described previously, the aquatic system at HPA consists of intertidal mudflats, soft-bottom benthos, and pelagic habitats. In November 1993, Biosystems Analysis, Inc. (Biosystems) conducted aquatic surveys in the offshore environment of HPA (PRC 1994f). Intertidal samples (the area between mean high and mean low tide) were collected on one transect in India Basin, seven transects in the South Basin, and one reference transect south of Candlestick Park. Transects led from the high tide mark to the seaward boundary of the intertidal zone with four sampling stations equally spaced. All sediment samples were sieved and the organisms were collected and identified (PRC 1994f).

Epibenthic (on the surface of the sediments) and benthic (below the surface of the sediments) organisms in the subtidal area (the area seaward of the low tide mark) were also collected from five transects. One transect was located in India Basin, three in South Basin, and one at the reference station. Transects led from the low tide mark seaward with four sampling stations equally spaced. All sediment samples were sieved and the organisms were collected and identified (PRC 1994f). Demersal fish trawls were performed along the same transects used for the subtidal sampling. All fish were collected and identified (PRC 1994f).

The aquatic environment near the ships and off the drydocks of Parcels C and D were not sampled during this study. The last survey to be conducted in the offshore areas surrounding HPA was in the mid- to late-1970s (COE 1975).

In the 1993 survey (PRC 1994f), the most abundant organisms in the epibenthic subtidal sediments were polychaete worms (*Typosyllis hyalina, Exogone lourei*), amphipods (*Caprella scaura, Ampelisca abdita, Rhacotropis* spp.), and a bivalve (*Musculus senhousia*). In the benthic subtidal sediments, a small, burrowing crustacean (*Hemileucon hinumensis*), amphipods (*A. abdita, Corophium heteroceratum*), and tubificid oligochaetes and nematode worms were most abundant. The intertidal samples were dominated by bivalves, with *Tapes japonica, M. senhousia,* and *Mytilus edulis* most abundant. Abundant offshore biota for each sampling location are summarized in Table 2-4.

The data from the 1993 survey were analyzed for species abundance, richness, diversity, and evenness. No consistent trends between sampling locations were observed. Three transects at the eastern end of South Basin were somewhat depressed relative to other transects sampled in terms of species abundance of benthic organisms. Abundances of intertidal organisms along transects adjacent to former oil ponds where an oily sheen was noted did not appear to be substantially lower than that found in other transects; however, abundance was not statistically analyzed (PRC 1994f).

In previous surveys of a subtidal station offshore of HPA (CH_2M Hill 1979), the amphipod *Ampelisca abdita* was consistently the most abundant species. The amphipods *Leptochelia dubia* and *Corophium acherusicum* were also abundant. Polychaetes represented the most diverse group, with 58 species identified during the survey; however, only *E. lourei* and *Mediomastus californiensis* were abundant. The 1975 COE survey of the HPA offshore area also reported *Ampelisca abdita* and *E. lourei* to be the most abundant species present.

The most abundant fish in the 1993 survey were anchovy (*Engraulis mordax*), surfperch (*Hyperprosopon ellipticum*), and various larval goby species. The California halibut (*Paralichthys californicus*) is a top predatory fish also found in the HPA offshore environment.

The federally endangered peregrine falcon (*Falco peregrinus*), which feeds primarily on shorebirds and pigeons, has been observed over HPA (PRC 1994c). Typical shorebirds observed in HPA

habitats that may serve as prey to the peregrine falcon include the willet (*Catoptrophorus semipalmatus*), black-bellied plover (*Pluvialis squatarola*), black turnstone (*Arenaria melanocephala*), killdeer (*Charadrius vociferus*), sanderling (*Calidris alba*), long-billed curlew (*Numenius americanus*), and dunlin (*Calidris alpina*). Piscivorous birds encountered in the intertidal areas include great blue heron (*Arolea herodius*) and snowy and great egrets (*Egretta thula* and *Casmerodius albus*). Pelagic piscivorous birds have also been observed at HPA, such as California brown pelican (*Pelecanus occidentalis californicus*) and double-crested cormorant (*Phalacrocorax auritus*).

2.4.3 Food Webs

Food webs representing the major trophic pathways in the terrestrial and aquatic habitats were developed for HPA (Figures 2-4 and 2-5). The terrestrial ecosystem at HPA includes a relatively simple community, dominated by a variety of weedy and ornamental plant species. Plants, the primary producers in these ecosystems, provide leafy vegetation, seeds, and fruits for the primary consumers. Typical primary consumers are herbivorous mammals, such as Botta's pocket gophers, California meadow voles, and black-tailed hares, and a variety of terrestrial insects (for example, grasshoppers). Granivores, such as mourning doves, house finches, and sparrows feed on the plant seeds. Terrestrial invertebrates, such as insects and earthworms, are consumed by a variety of birds including mockingbird, meadowlark, loggerhead shrike, and American kestrel. Top predators include red-shouldered hawk, peregrine falcon, and red fox (PRC 1994c).

The offshore habitats of HPA include intertidal and subtidal mudflats, and salt marshes supporting a well developed food web (Figure 2-5). Nutrient-releasing decaying organic matter and primary producers, such as phytoplankton and algae, form the foundation of the aquatic food web. Primary consumers, such as zooplankton, and benthic crustaceans (amphipods, isopods, and decapods), and annelids (polychaetes and oligochaetes) form an integral prey base for shorebirds, ducks, and fish. Shorebirds found feeding on the mudflats include willets (*Catoptrophorus semipalmatus*), long-billed curlews (*Numenius americanus*), and black-bellied plovers (*Pluvialis squatarola*). Ducks found feeding in the intertidal and subtidal areas include surf scoters (*Melanitta perspicillata*) and buffleheads (*Bucephala albeola*). Typical fish that prey on benthic invertebrates are the cheekspot gobies (*Ilypnus gilberti*), Pacific staghorn sculpins (*Leptocottus armatus*), and white croakers (*Genyonemus lineatus*). Pelagic fish such as Pacific herrings (*Clupea harengus palasii*) and northern

anchovies (*Engraulis mordax)* consume zooplankton. The gobies and pelagic fish, in turn, are consumed by piscivorous birds and fish. Top predators feeding in the aquatic environment include peregrine falcon, red-shouldered hawk, California brown pelican, and California halibut (PRC 1994c).

Linkages between the terrestrial and aquatic systems exist at HPA primarily through birds feeding on both terrestrial and aquatic prey. Such birds are the peregrine falcon, which consumes both shorebirds and land birds, and the red-shouldered hawk, which consumes shorebirds and terrestrial birds and mammals. Red fox may also consume shorebirds in addition to terrestrial birds and mammals.

3.0 IDENTIFICATION AND PRIORITIZATION OF CONTAMINANTS OF POTENTIAL CONCERN

In Task 2 of Phase 1A, chemical data from previous HPA sampling efforts were reviewed and compiled to identify chemicals of potential concern (COPC) (PRC 1994b). PRC compiled summary reports of potentially hazardous chemicals in soil, groundwater, and sediment; these summaries include frequency of detection and mean and maximum concentrations. Chemical data from onshore and offshore locations were analyzed separately. Onshore data included those for soils and groundwater; offshore data included those for sediment, storm water, bay water, mussel tissue, and storm sewer sediment.

3.1 ONSHORE COPCs

Two principle concerns with onshore contamination have been identified: (1) exposure to ecological receptors through contact with or ingestion of contaminated soils or food, and (2) transport of contamination from soils to the marine environment through groundwater. Currently, there are no ecological screening benchmarks for terrestrial receptors. Because the types of receptors, exposure pathways, and distribution of habitat relative to contamination are different at every site, identification of COPCs for terrestrial receptors requires a more detailed analysis. This analysis will be conducted in Phase 1B.

To address the issue of potential transport of soil contaminants to the marine environment, two screening analyses were conducted. First, chemical concentrations in soils were compared with soil levels in the Bay Area that are considered to be protective of the basin plan marine water quality objectives (RWQCB 1993). Second, chemical concentrations in groundwater were compared with ambient water quality criteria for marine life. These analyses are presented in detail in the Phase 1A task summary report (PRC 1994b) and are summarized below.

3.1.1 COPCs for Onshore Soils

Soil data from Parcels B, C, D, and E were analyzed by parcel for comparison with the RWQCB basin plan soil levels protective of marine water quality (RWQCB 1993). For each parcel, soil data were divided into above-groundwater and below-groundwater data. The depth to groundwater varied between parcels, but was generally not less than 3 feet bgs. Chemicals with at least one percent of the samples exceeding the soil criteria by parcel and soil strata are presented in Table 3-1. These COPCs may pose a risk to aquatic receptors if they (1) are ingested or absorbed by terrestrial receptors, (2) percolate to the groundwater and migrate to surface water, (3) are discharged in storm water or overland flow, or (4) are carried in soil erosion to the intertidal zone.

In summary, all of the inorganic chemicals and cyanide were detected at least once in above-groundwater soil samples in Parcels B, C, D, and E. Of the organic compounds for which RWQCB soil values were available, total polynuclear aromatic hydrocarbons (PAH), total PCBs, and some pesticides exceeded criteria for both above- and below-groundwater soils in Parcels B, C, D, and E (PRC 1994b). Four general trends were apparent from the data analysis: (1) PAHs were detected in about 10 percent of the samples, (2) PCBs and DDT were detected in no more than 5 percent of the samples, (3) other pesticides were detected in about 1 to 3 percent of the samples, and (4) all other organics with RWQCB soil values were detected in $\leq$ 1 percent of the samples.

3.1.2 COPCs in Groundwater

Groundwater COPCs were identified by compiling data by parcel and comparing chemical concentration with water quality criteria (PRC 1994b). Water quality criteria included the California basin plan water quality objectives for the protection of aquatic marine life in surface waters with

salinities ≥ 5 parts per thousand, and EPA's ambient water quality ("goldbook") criteria (EPA 1987). Detailed results of this screening are presented in the Phase 1A Task 2 summary report (PRC 1994b) and by parcel in Table 3-2. In general, trace metals were frequently detected at concentrations exceeding water quality criteria. Other COPCs identified on this basis include phenanthrene, PCBs, DDT, and other pesticides. There are several PAH compounds for which water quality criteria have not yet been promulgated. Although maximum concentrations were low to moderate, COPCs were frequently detected and may adversely affect aquatic life. Therefore, many chemicals were retained as COPCs for groundwater (Table 3-2).

For the Phase 1A screening, the relationship between sample location and groundwater gradients was not analyzed. Because groundwater flow around HPA is very complex, a more detailed analysis of the sample locations and groundwater flow is proposed for Phase 1B; the methodology for such an analysis described in Section 6.1.

3.2 IDENTIFICATION OF COPCs

The offshore sediments at HPA contain trace metals, organotins, PAH, pesticides, and PCBs (PRC 1994b). Facility-wide COPCs were developed for the offshore sediments based on their potential to pose a risk to ecological receptors, and are discussed in Section 3.2.1. Hazard quotients and hazard indices, which were calculated for the Environmental Sampling and Analysis Program (ESAP) offshore sediment sampling stations using the National Oceanic and Atmospheric Administration (NOAA) Effects Range Low (ER-L) and Effects Range Median (ER-M) values (NOAA 1991), are discussed in Section 3.2.2. These hazard quotients and indices were developed as a screening method to identify offshore areas requiring further sampling in order to trace movement of onshore contamination offshore.

3.2.1 COPCs For Offshore Sediments

COPCs for the offshore sediments, which were developed and presented in the Phase 1A ecological risk assessment Task 2.0 summary report (PRC 1994b) were determined using sediment data collected during the ESAP (ATT 1991). The ESAP consisted of 20 offshore sampling locations and 43 intertidal sampling locations (Figure 3-1). Three of the 20 offshore sampling locations were

designated as reference stations (not shown on Figure 3-1): the south side of Candlestick Park (RS-1), the north side of Sierra Point (RS-2), and in San Pablo Bay (RS-3). The remaining 17 stations were offshore of HPA. A surface sample, consisting of a composite of 10 surface grab samples collected within the sampling area, and one subsurface sample at 2.5 feet were analyzed at each of the 20 offshore sampling locations. One surface grab sample and one subsurface sample at 0.5 foot were analyzed at each intertidal location.

All sediment data collected at each station during the ESAP, except those from the three reference station samples, were combined to develop facility-wide chemical concentration means that were compared to ER-L and ER-M values. Facility-wide sediment COPCs are listed in Table 3-3. All data used in developing the facility-wide COPCs were submitted as part of the Phase 1A ecological risk assessment task summary reports (PRC 1994b). COPCs are further defined for each station in the following section.

3.2.2 Sediment Hazard Quotients and Hazard Indices

For facility-wide COPCs, hazard quotients and hazard indices were developed using ER-L and ER-M values to focus the review of station-specific data. Hazard quotients and hazard indices were developed based on draft guidance provided by DTSC (1994a,b). A hazard quotient is defined as the ratio of a concentration in a medium to a reference concentration that is not expected to adversely affect biota. A hazard index is the sum of hazard quotients for chemicals acting by a similar mechanism. For initial screening purposes, all chemicals were considered to be acting by a similar mechanism in the offshore invertebrates. The formulas used for this preliminary analysis are presented below.

$$\frac{\textit{Concentration In Medium}}{\textit{Reference Concentration}} = \textit{Hazard Quotient (HQ)}$$

$$\sum_{x=1}^{\infty} HQ_x = \textit{Hazard Index (HI)}$$

ER-L and ER-M values based on studies on marine and estuarine sediments (Long and others 1994) were used as reference concentrations. No hazard quotients were developed for chemicals without

ER-L or ER-M values for this preliminary screening task. Hazard quotients and indices were developed separately for each of the surface and subsurface samples collected from the 20 offshore stations. The intertidal samples were grouped according to their proximity to installation restoration (IR) sites, and the means were used to develop hazard quotients and hazard indices. When developing hazard quotients and hazard indices for the intertidal stations, no distinctions were made between the surface samples and the 0.5-foot samples.

Tables 3-4 and 3-5 summarize the number of chemicals detected and the hazard indices for surface and subsurface sediments, respectively, for each of the 20 ESAP stations. Figure 3-1 shows the locations of 17 of the ESAP stations offshore of HPA. Figures 3-2 through 3-6 show the ESAP sampling locations by parcel with station-specific tables summarizing the detected concentrations, ER-L values, ER-M values, ER-L-based and ER-M-based hazard quotients, and the ER-L-based and ER-M-based hazard indices. It is important to note that the chemicals in these tables represent only those detected for which ER-L and ER-M values have been developed. Figures 3-7 through 3-10 graphically compare the hazard indices of each station. Tables containing values of all chemicals detected, ER-L and ER-M values, hazard quotients, and the hazard index for each station appear in Appendix A.

The percent contribution of each chemical's hazard quotient to the overall hazard index was calculated to identify chemicals that are significant components of the contaminant load at each station. If a chemical's hazard quotient contributed 10 percent or more to the hazard index, it was considered to be a driving factor; however, many other COPCs for which no ER-Ls or ER-Ms have been developed were detected in varying concentrations and may also be major components in the overall risk. Significant contributors to the contaminant load-based ER-Ls and ER-Ms are listed in Tables 3-6 and 3-7; all chemicals detected at each station are listed in Appendix A.

4.0 DEVELOPMENT OF CONCEPTUAL SITE MODELS AND ASSESSMENT AND MEASUREMENT ENDPOINTS

In Tasks 5.0 and 6.0 of the Phase 1A ecological risk assessment, the contaminant migration pathways, contaminant exposure routes, and food web interactions that are of concern at HPA were analyzed, conceptual site models were developed, and the selection of potential assessment and measurement

endpoints was finalized. This section summarizes the results of these tasks, which influence Phase 1B, and discusses how these data will be used and refined in Phase 1B.

4.1 CONCEPTUAL SITE MODELS

Terrestrial and aquatic food webs emphasizing proposed assessment and measurement endpoints were developed in Phase 1A (Figures 2-4 and 2-5). These food webs, combined with the contaminant migration and exposure pathway analyses, were used in Phase 1A for the development of the site conceptual models for each parcel, which are shown in Figures 4-1 through 4-4. The following data gaps were identified from the conceptual models; each will be addressed in Phase 1B.

- The degree to which contaminants in soil and sediment are available for receptor uptake is not known. Characterization of bioavailability is necessary because bioavailability influences contaminant exposure and potential ecological risk to receptors. Evaluation of bioavailability, especially in sediment, is one component of the proposed sampling plan, which is introduced in Section 6.0.

- Anoxia in the sediments may prevent or retard contaminant degradation, and may cause unsuitable habitat conditions for benthic receptors. Since areas having anoxic sediments may not be habitable, there may be no receptors exposed to contamination. Re-suspension of these sediments would be expected to release contamination to other areas having receptors. Section 6.0 includes discussions of the methodology for characterization of the vertical contamination profile that includes anoxic and oxic analyses.

- In addition to acting as a reservoir of contaminants, the sediments may be receiving contaminants from groundwater. The relative contribution of groundwater to contamination in sediments is not known. The migration pathways from groundwater to the bay will be further characterized and analyzed during Phase 1B as discussed in Section 6.0.

4.2 ASSESSMENT AND MEASUREMENT ENDPOINTS

In Task 6.0 of Phase 1A (PRC 1994d), assessment and measurement endpoints were proposed according to EPA guidance (1989, 1992). Protection of the population was used as the endpoint for all species except those for which the individual is the unit of protection because of federal or state threatened or endangered status. Table 4-1 is a checklist of the criteria used to select assessment endpoints. Taxa reported to use the habitats at HPA were considered as possible assessment

endpoints; in general, assessment endpoints that have important ecological, toxicological, and social considerations at HPA were chosen. Factors influencing the selection of endpoints included their occurrence at HPA, ecological significance, conservation status, life and natural history characteristics, and toxicological susceptibility of receptors. Known and potential contaminants present and their mechanisms of toxicity, the potential for bioaccumulation, and the spatial and temporal exposure patterns and pathways were also considered.

The assessment endpoint receptors chosen play significant roles in the ecology of HPA as predators, such as the great blue heron (*Ardea herodias)*; as common prey species, such as the benthic invertebrates or gobies; or as species performing important ecological functions in the bay, such as the cycling of organic carbon by benthic invertebrates. These assessment endpoints are also valued by society, as evidenced by their important economic and recreational capacities and their conservation status.

Taxa selected as assessment endpoints represent ecologically important and toxicologically sensitive groups of receptors. For example, the potential for risk to the great blue heron can indicate potential risks for other piscivorous birds having similar exposure routes and physiology. Also, the risk characterizations for the American kestrel (*Falco spaverius*) can be used to evaluate potential risks to other birds of prey.

Risks to assessment endpoints are characterized using measurement endpoints. A measurement endpoint can be directly or indirectly related to the assessment endpoint. An example of a direct relationship between a measurement endpoint and an assessment endpoint is the use of bioassays (measurement endpoint) to estimate risk to the benthic invertebrate community (assessment endpoint). An example of an indirect relationship is the use of exposure and effects modeling to estimate risk to high trophic level assessment endpoints such as the great blue heron. Table 4-2 summarizes the aquatic avian assessment endpoints and proposed measurement endpoints. Protection of populations of the American kestrel is the terrestrial assessment endpoint. The assessment and measurement endpoints will be evaluated in the context of the conceptual model for HPA and are designed to function together in quantitative models for characterization of potential exposure and effects at HPA. Figure 4-5 is a HPA conceptual site model illustrating the relationship between assessment and measurement endpoints and depicting contaminant flow and exposure routes for two major exposure

pathways, dermal exposure and ingestion. This model provides the basic framework within which risk to assessment endpoints will be evaluated.

For most assessment endpoints, exposure and effects will be quantitatively analyzed for qualitative risk characterization. Because of limited or undetermined use of the site by some taxa, such as the peregrine falcon, or because of uncertainties involved in the proposed effects assessment methodologies, a quantitative analysis of exposure and effects may not be possible for every assessment endpoint. These factors, however, do not merit elimination of such taxa from consideration of potential risk, especially when the species is of special conservation concern or when the species might experience high levels of exposure. If, in the process of gathering data needed for the quantitative exposure and effects analysis, it becomes apparent that the required data are not available for some assessment endpoint taxa or that the methodology will not permit a quantitative exposure and effects assessment, exposure and effects will be qualitatively analyzed.

This qualitative risk analysis will be based on the available data on the species, as well as the quantitative exposure and effects assessment conducted on assessment or measurement endpoint taxa in related guilds or those that are possible prey items. For example, a qualitative exposure and effects assessment for the peregrine falcon may be based partly on the quantitative analyses for the American kestrel by virtue of similarity in guild, and for the willet by virtue of its possible use as prey.

Potential measurement endpoints were identified for assessment endpoints. The assessment endpoint for the aquatic system at HPA is protection of the benthic invertebrate community. Risk to this assessment endpoint will be measured directly using solid-phase amphipod and pore water sea urchin bioassays. Details on these bioassays, interpretation of their data, and characterization of risk to the benthic invertebrate community are discussed in Section 7.1.

Unlike the benthic invertebrate community, which can be measured directly using bioassays and bioaccumulation measurements as described in Sections 6.0 and 7.0, aquatic avian assessment endpoints cannot be measured directly. Therefore, other means of identifying potential risk were developed for these assessment endpoints, namely exposure and effects modeling.

Table 4-2 lists the aquatic avian assessment endpoints and the potential measurement endpoints, and describes the relationship between the two. Data on prey preferences will be cross-referenced with data on prey species known to occur and to be abundant at HPA to derive species for which field measurements of tissue residues would be taken.

The measurement endpoints proposed for characterization of risk to aquatic avian assessment endpoints consist of two general types: (1) field measurement of tissue contaminant concentrations for prey species important to receptors, and (2) direct toxicity and bioaccumulation testing for important aquatic prey species. The first type of measurement endpoint will be used in the quantitative exposure model to estimate a daily chemical dose for each aquatic avian assessment endpoint and COPC. The sampling and analysis plan will finalize the prey species to undergo tissue residue analysis, the sampling locations, the sampling methodology, and the chemicals that will analyzed for.

The second type of measurement endpoint consists of toxicity and bioaccumulation tests on benthic invertebrates and fish described in Section 7.2. Where quantitative risk analyses are not feasible, these tests will be used to evaluate the health of the prey bases of aquatic avian assessment endpoints. As discussed above, potential exposure and effects cannot be evaluated quantitatively for all assessment endpoints. For example, for some species, such as the peregrine falcon, it may not be feasible to measure tissue residues in the prey species having the most significant exposure, which in this case would be shorebirds. Furthermore, appropriate prey species for which tissue residue can be measured may be exposed to contaminants from other Bay Area locations because of the prey's mobility (for example, measuring tissue residues in northern anchovy as a measurement endpoint for the brown pelican). These prey would not provide an indication of the contaminant burdens obtained only from HPA. Another instance in which a quantitative evaluation of risk may not be appropriate is for far-ranging assessment endpoints that may be exposed to contamination from other locations. Consequently, if a measurement endpoint suitable for quantitative evaluation of exposure to and effects of HPA contamination cannot be selected, a qualitative analysis may be performed instead.

Furthermore, should future data suggest other important or appropriate assessment endpoints, the current endpoints will be modified as required. The information required and the methodology for finalizing measurement endpoints is discussed in Sections 8.0 and 9.0 of this work plan.

5.0 OBJECTIVES OF PHASE 1B ECOLOGICAL RISK ASSESSMENT

The purpose of the Phase 1B ecological risk assessment is to collect data to (1) obtain a general view of the nature and extent of the offshore contamination, (2) determine the risk posed to aquatic receptors by offshore contamination using quantitative measurements, and (3) further define the risk posed to terrestrial receptors from onshore contamination.

To accurately characterize risk to aquatic ecological receptors, additional data are needed to describe the nature and extent of contamination in offshore sediments and to investigate potential toxic effects of the contamination. The nature and extent of the offshore sediments will be characterized by measuring sediment chemistry, pore water chemistry and parameters that effect the bioavailability of a contaminant such as grain size, total organic carbon, and pH. In addition to these measurements, the contribution of groundwater to sediment contamination must be assessed. Section 6.0 describes the effects data to be gathered and their importance in determining the nature and extent of contamination. Offshore sampling locations are also presented in Section 6.0. Section 7.0 discusses the effects and exposure data to be gathered, which include direct toxicity measurements such as bioassays and tissue residues. Section 8.0 presents the risk characterization which involves combining the effects and exposure data to evaluate risk to aquatic receptors.

There are adequate onshore data (soil and groundwater chemistry) for the terrestrial assessment Additional effects and exposure data (bioassays, tissue residue studies) may be necessary to fully characterize terrestrial risk. Section 9.0 describes the model to be used in assessing risk to terrestrial receptors and the screening process to determine if additional terrestrial data are necessary.

All data and information gathered will be compiled into a final ecological risk assessment report as described in Section 10.

6.0 NATURE AND EXTENT OF CONTAMINATION

The ESAP sediment analytical data (Section 3.2 and Appendix A) indicate that the sediments offshore of HPA are contaminated. The source, extent, and potential toxicity of this contamination cannot be determined with the available data, and further offshore characterization is necessary. This section

describes how the groundwater contribution to the sediments will be assessed, the factors to be considered when assessing the nature and extent of contamination, the rationale for additional offshore sampling, the locations considered for sampling and proposed sampling methods, and the proposed analyses to be performed.

No additional chemical data will be needed for the onshore areas for the Phase 1B ecological assessment as adequate data already exist.

6.1 EVALUATION OF THE GROUNDWATER-TO-BAY PATHWAY

As part of determining the nature and extent of contamination, the contribution of groundwater to sediments needs to be examined because the primary means of exposure of ecological receptors to contaminants in groundwater is through the input of groundwater to the bay. As stated in Section 2.3 and shown in Figure 2-2, groundwater flow in the A-aquifer, B-aquifer, and the Bedrock aquifer is generally toward the bay. Groundwater is in direct contact with the bay along the shore of HPA, where it is tidally influenced. The groundwater flow direction indicates that chemicals in groundwater may be transferred offshore, where they may be bound to the sediments or released to the water column resulting in exposure to aquatic biota (Figure 2-2). To evaluate this pathway, groundwater data were compiled for each parcel and compared to the ambient water quality criteria in the Phase 1A Task 2 summary report (PRC 1994b). Results of the comparison indicate that the concentrations of several chemicals within each parcel exceed the screening criteria and may pose a risk to aquatic receptors if exposed to these levels. This comparison was done on a parcel-wide basis and did not account for attenuation or dilution resulting from factors such as contaminant sorption to soil particles in groundwater, which occurs as groundwater migrates through soil to the bay.

Whether contaminants in groundwater migrate to the bay with the general flow of groundwater is not known. Currently, the concentrations of chemicals in groundwater at the groundwater-bay water interface have not been directly measured since this interface is not well defined. One estimate of these concentrations can be made from the data collected at groundwater monitoring stations near the bay. Although the position of these stations relative to the groundwater-bay water interface is not known, these data may be used to describe some of the potential groundwater-bay water interactions. Data from these bayside monitoring stations will be compared against the ambient water quality

criteria, without applying any dilutions or attenuation factors, to identify contaminants exceeding screening criteria. Site-specific dilution and attenuation factors may be developed if the current data allow for an accurate hydrology model to be developed and reasonable factors to be determined; however, the nature of the fill, variability of tidal influences, estimates of groundwater flow rates, and other complicating factors make it difficult to model attenuation and dilution accurately. Chemicals exceeding criteria in the groundwater will be compared to offshore sediment data to explore the relationship between groundwater and offshore contamination and the possible contribution of groundwater to offshore contamination.

6.2 FACTORS TO BE CONSIDERED WHEN ASSESSING THE NATURE AND EXTENT OF OFFSHORE SEDIMENT CONTAMINATION

The nature and extent of contamination cannot be determined solely by whole chemistry measurements; the bioavailability and toxicity of the sediment must be considered as well. In determining the toxicity of the sediments, factors that influence an organism's exposure to the chemical must be assessed. For example, the offshore invertebrate community, dominated by mollusks, crustaceans, and annelids, has limited mobility and would be expected to spend its entire post-metamorphal life cycle in the offshore sediments. These organisms may be exposed to sediment-associated contaminants through ingestion of the sediment, dermal contact with the sediment and pore water, respiration of the pore water, or all three mechanisms. These organisms are not exposed to the same concentrations of chemicals as reflected in total chemistry, but to a bioavailable fraction of that total.

6.2.1 Bioavailability

Bioavailability of sediment-associated contaminants is the fraction of the total contaminant in the pore water and on sediment particles that is available to an aquatic organism (Landrum and Robbins 1990; Mayer and others 1994). This section describes the importance of bioavailability and pore water in assessing sediments.

Measurements of bioavailability and the factors that influence it include the following assumptions:

- The bioavailability of a contaminant is a more realistic measurement of toxicity than total chemistry.

- The bioavailability of contaminants depends on their ability to penetrate biological membranes, whether the contaminants are ingested or contacted dermally. As such, the bioavailability of a contaminant is determined by its chemical speciation.

- Generally, a contaminant is more bioavailable in the dissolved phase, and the risk of a contaminant decreases as it is immobilized by sorption processes. The bioavailability of a contaminant decreases when it is immobilized by sorption processes such as when it is sorbed to solid-phase materials (soils/sediments and organic matter).

- The bioavailable fraction of a contaminant has been shown to be present in the pore water fraction of the sediment when using the appropriate extraction method.

- The bioavailability of a contaminant can be assessed by determining its bond strength to controlling solid phases. Bond strength can be inferred using extraction methods. Partitioning between the solid and liquid phases can be estimated using equilibrium methods.

There are several parameters that are important in understanding bioavailability of sediment contaminants. The more important of these are: acid volatile sulfide (AVS) (Di Toro and others 1990), total organic carbon (TOC) (Di Toro and others 1991), pH, and grain-size. Sulfide is important in controlling the bioavailability of metals in anoxic sediments. AVS is the reactive pool of solid-phase sulfide that is available to bind with selected metals (cadmium, copper, lead, mercury, nickel, and zinc) that are solubilized during the acidification step (simultaneously extracted metal, SEM). This step may also affect antimony, bismuth, and chromium, if present. Relative amounts of SEM and AVS are important in the prediction of potential metal bioavailability. The protocol that is now under review (Allen and others 1991) uses the same conditions for release of both sulfide and metal from the sediment and thus provides a useful means of assessing the amount of metal associated with sulfide.

TOC is a measure of the amount of organic matter in sediments and is another parameter that affects bioavailability. Organic matter in sediment forms food for many of the benthic organisms. Organic-poor sediments are not capable of supporting abundant benthic organisms. Very organic-rich sediments (TOC greater than 15 percent) may be inhospitable to many larger organisms because of microbial activity, which consumes all of the available oxygen and may form natural toxic substances such as ammonia and sulfides (MacDonald and others 1992). In addition, sediments with high TOC

content tend to accumulate higher concentrations of toxic substances, including low-solubility organics and some metals, than do low-TOC sediments from the same area. The sediment chemical value of an organic contaminant, such as bulk PAH, is divided by the TOC to obtain a normalized organic chemical value in the sediment. This method provides a better estimate of the bioavailable fraction of organics present in the sediment that may be available for uptake by a benthic receptor.

Grain-size and pH play an important role in understanding and confirming the bioavailability of various chemicals to aquatic organisms. Sediment grain size is one of the fundamental sediment characteristics for two reasons (MacDonald and others 1992). First, the habitat for benthic organisms is determined in part by the grain size of the sediments; different sediment textures support different communities of benthic organisms. Second, grain size is an important factor in the accumulation of toxic substances in sediments. Exposure of dissolved substances to particulate matter in the water column results in the sorption of those substances by particulates, which then settle to form sediments. Finer particles, which have larger surface area per mass (dry weight), have the potential to accumulate more of the toxic substances per dry weight than do the coarser particles.

Mayer and others (1994) provide a good review of the effect of pH on bioavailability and toxicity of various chemicals. Changes in pH affect metal partitioning by changing the metal solubility and speciation, and thereby the concentration of the bioavailable species (Campbell and others 1988). There is some evidence that metal uptake and toxicity for cadmium, copper, and zinc decrease with increasing hydrogen ion concentration (from Campbell and Stokes 1985 as cited in Campbell and others 1988).

6.2.2 Pore Water

Pore water is predicted by equilibrium partitioning theory to be the controlling exposure medium in the toxicity of sediments to infaunal organisms (Adams and others 1985; Di Toro 1988 as cited by Carr 1993). A variety of studies of benthic organisms indicate that pore water concentrations of metals correspond very well with the bioavailability of metals in test sediments (Ankley and others 1994). Metal concentrations in pore water can be compared to water-based toxicity data to predict not only the presence but the extent of metal toxicity in sediments. Ankley and others (1994) also report that the toxicity of nonionic organics correlates with the toxicity of water-only exposure to

benthic and epibenthic organisms. Ankley and others (1994) also found that pore water extracts of cadmium, zinc, nickel, and copper could be used to accurately predict the occurrence and extent of toxicity to amphipods. Swartz and others (1985) (as cited in Carr and Chapman 1992) found a correlation between acute toxicity of cadmium-spiked sediments and pore water.

Bioavailability of organics in pore water is affected by organic carbon, which controls the partitioning of nonionic organics. Salinity may also affect the bioavailability of organics in pore water.

Pore water has been extracted by many methods in the past with varying results. However, the U.S. Environmental Protection Agency laboratory in Duluth, Minnesota, and the U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center in Columbia, Missouri, have developed, used, and tested the extraction of pore water by high-speed centrifugation without filtration. This method appears to extract both metals and nonionic organics for the purpose of toxicity testing (Ankley and Schubauer-Berigan 1994).

6.3 RATIONALE FOR ADDITIONAL OFFSHORE SAMPLING

Further offshore sediment sampling is necessary for two reasons. First, the nature and extent of contamination in offshore sediments has not been characterized in areas that are near known chemical sources at HPA. Sampling will focus on tracking contaminants from onshore sources to offshore sediments, as well as any offshore spills or discharges from HPA activities. This strategy is consistent with the IRP and is required under CERCLA. Second, as stated in Section 6.2, additional information on the bioavailability and toxicity of the sediments through site-specific measurements must be gathered to characterize risk to aquatic receptors.

6.3.1 General Locations For Additional Offshore Sampling

Sampling locations focus on areas of potential contamination from activities at HPA. Proposed locations are (1) storm water outfall discharge zones, (2) areas offshore from the IR sites, and (3) offshore areas where spills or discharges have been observed or documented. Locations were discussed and finalized in a series of meetings between the Navy and the regulatory agencies. Sampling locations are shown on Figures 6-1 through 6-4.

Storm Water Outfalls: The contaminant concentrations in sediments in the storm sewer system are above both ecological and human health screening levels (PRC 1994b,d). It is necessary to sample the major storm sewer outfall discharge zones to determine if contamination has been transported to offshore sediments. The offshore sediment samples collected as part of the ESAP cannot be used to determine potential discharge contamination because the sampling design did not focus on the storm sewer outfalls.

Offshore of Installation Restoration Sites: Information gathered during the ESAP and the observations during the benthic surveys conducted in the Phase 1A ecological risk assessment indicate the possibility of offshore contamination that can be attributed to onshore IR sites such as the industrial landfill (IR-1), the bay fill area (IR-2), and the oil reclamation ponds (IR-3). This information included observations of oil in sediments collected off of IR-3 and sediment sample results (Section 3.2 and Appendix A) indicating multiple chemicals exceeding screening criteria offshore of IR-1 and IR-2 (PRC 1994b,f). Additional offshore sediment sampling is required to determine if contaminants have been transported from these onshore sources to offshore sediments.

Offshore Areas of Spills or Discharges - Preliminary Assessment of Parcel F: As part of the Phase 1B ecological risk assessment, a preliminary assessment of Parcel F will be conducted under which records will be reviewed and installation personnel will be interviewed to identify any spills or discharges that may have occurred offshore of HPA. Additional areas of potential contamination caused by HPA activities discovered during this assessment will be incorporated into the sampling and analysis plan. This step will provide comprehensive identification of known historical contaminant releases resulting from HPA activities.

Currently, there are no approved reference stations for San Francisco Bay. The RWQCB has been conducting a study to identify reference areas, which is scheduled to be released in late June 1995 (PRC 1995a). Two of the five stations that will be recommended this summer by the RWQCB may be usable as reference stations for this project. One of these stations will be north of Coyote Creek, and the other will be south of Coyote Creek.

6.3.2 Proposed Sampling Methods

Offshore samples will be collected using a 0.1-m^2 Van Veen Grab, a 2-inch-diameter gravity sediment corer, and a 4-inch-diameter Vibra-Corer. Samples will be collected from 28 transects leading from onshore sources to offshore sediments, and from two individual sampling locations not associated with a transect (Figures 6-1 through 6-4). Transects will extend far enough to determine the extent of contamination related to HPA activities, and samples will be collected from selected locations along transects to detect any gradients from the potential sources. Surface sediment samples will be collected at 105 stations. The vertical extent of contamination will be assessed by collecting 3-foot cores at 8 stations and 6-foot cores at 11 stations. Cores will be placed in areas where sediment is likely to accumulate, creating a greater vertical extent of contamination. These positions were estimated based on the sediment budget study for San Francisco Bay, which determined areas of erosion and deposition for the period from 1955 to 1990 (COE 1992). The 6-foot cores were placed in areas where the study showed deposition of 6 feet or greater; the 3-foot cores were placed in areas that the study depicted as having a deposition of 3 feet or less. A limited number of cores were placed in areas that the study determined to be erosional to allow for comparison with the depositional areas. The sampling locations of the deep core and areas of erosion and deposition are shown in Figures 6-1 through 6-4. The sediment cores will be split into 1-foot sections and tested separately to determine vertical contamination gradients.

Sampling methods, sampling locations, and analyses to be performed at each station are presented in the field sampling plan (FSP) that accompanies this work plan.

6.4 ANALYSES OF SEDIMENT CHEMISTRY AND BIOAVAILABILITY MEASUREMENTS

This section includes a discussion of the methods that will be used to analyze chemical and physical parameters of the sediments.

6.4.1 Chemical Analysis

ESAP sampling of sediments indicated that elevated levels of trace metals, semivolatile organic compounds (SVOC), pesticides, organotins, and total petroleum hydrocarbons (TPH) are frequently

detected. All sediment and pore water samples will be analyzed for the same core group of trace metals, SVOCs, pesticides, PCBs, organotins, and TPH. VOCs will only be analyzed at a limited number of station because they were not detected in the majority of ESAP samples. Analytical procedures will follow standard EPA methods. The analytes and contract-required detection limits for sediment and water samples are listed in the quality assurance project plan (QAPP). Samples and the associated analyses are listed in the FSP.

6.4.2 Analysis of Parameters Affecting Bioavailability

As stated in Section 6.2, additional analyses of the sediments other than total chemistry are required to fully characterize the bioavailable fraction of contaminants; these additional analyses of bulk sediment include pH, TOC, grain size, AVS/SEM, and sediment biochemical oxygen demand. Pore water samples will be analyzed for dissolved oxygen, hydrogen sulfide, ammonia, pH, and salinity to assess bioavailability. Field measurements will include pH, salinity, temperature, and dissolved oxygen. The protocols for determining particle size, sediment TOC, AVS/SEM, and sediment biochemical oxygen demand are described in the QAPP, Appendices A7, A-8, A-9, and A-10, respectively. Quality assurance and quality control (QA/QC) procedures are also discussed in the QAPP.

6.4.3 Data Analysis and Interpretation For Chemical and Bioavailable Analysis

Solid-phase and pore water sample concentrations will be compared to existing criteria. In Phase 1A, solid-phase sediment chemistry values were compared to the ER-L and ER-M values. Since the time of that analysis, the appropriate screening criteria for San Francisco Bay have been discussed and evaluated. While bay-wide screening criteria are still under development, it is proposed for this project that the wetland creation and upland beneficial reuse values developed for dredging and disposal of dredge spoil (Wolfenden and Carlin 1992) and the San Francisco Bay mean values presented in the San Francisco Estuary Pilot Regional Monitoring Program Sediment Studies (RWQCB 1994) be used. These criteria are much more appropriate for HPA than the ER-L and ER-M values because they are bay-specific. If bay-wide screening criteria are agreed upon before the data are analyzed, such criteria will be adopted. Screening values for the pore water will be the ambient water quality criteria (EPA 1994c) which have been adopted for San Francisco Bay.

AVS/SEM will be used to determine the bioavailable fraction of a chemical in sediment. The extract removes all metals which can be assumed to be bioavailable to the benthic receptors. These values are considered the normalized metals values representing the bioavailable fraction. The bioavailable fraction of organics will be determined by taking the sediment chemical value, such as PAHs, and dividing that value by TOC to obtain a normalized organic chemical value in sediment. The accuracy of the resultant bioavailable fractions will then be verified by assessing the grain size and pH data.

Use of these screening criteria and the estimates of biovailable data in the overall risk evaluation is presented in Section 8.1.

7.0 DIRECT MEASUREMENTS OF TOXICITY AND TISSUE RESIDUE

Risk to ecological receptors posed by contaminants at a site is best assessed by correlating measurements of bulk chemistry and estimates of bioavailability to direct measures of toxic effects. Two methods of directly assessing toxicity and effects using bioassays and tissue residues are discussed below.

7.1 SEDIMENT BIOASSAYS

Zooplankton, amphipods, shrimp, mollusks, polychaetes, echinoderms, fish, and the marine bacterium *Photobacterium phosphoreum* have all been used to assess sediment toxicity (Pastorok and Becker 1989; MacDonald and others 1992; Lamberson and others 1992). No single test or organism can determine sediment toxicity; rather, a suite of both lethal and sublethal sediment tests with more than one organism will best assess the toxic effects of sediments (Pastorok and Becker 1989; MacDonald and others 1992).

Elutriate, solid-phase sediment, and pore water have all been used to assess the toxicity of sediments. Tests with solid-phase sediment provide a measure of the direct uptake of contaminants from sediment to the test organism. Elutriates provide information on the availability of dissolved contaminants to the test organisms that live close to the sediment. Pore water tests are more sensitive than elutriates at detecting sediment toxicity (Ankley and others 1991). Ecological effects of contaminants in the aquatic habitat on benthic invertebrate receptors will be measured using solid-phase sediment

bioassays and pore water bioassays. These toxicity tests provide a measure of the effects of the bioavailable fraction of the contaminants to benthic receptors. Sediment toxicity tests will indicate the toxicity of sediment-sorbed contaminants ingested by or exposed dermally to the benthic receptors. Pore water tests indicate the toxicity of contaminants that affect the benthic receptors dermally and through respiration. The types of bioassay that will be used to evaluate toxicity in the sediment and pore water are described below.

7.1.1 Solid-Phase Bioassay

Amphipods are an important and abundant ecological component of soft-bottom estuarine and marine habitats. Amphipods are more sensitive to contaminated sediments than other major taxa and are the first to disappear from benthic communities impacted by pollution (Flegal and others 1994). The American Society of Testing and Materials (ASTM 1991) has developed and approved the acute 10-day static sediment protocols for five different estuarine and marine amphipods: *Rhepoxynius abronius*, *Eohaustorius estuarius*, *Ampelisca abdita*, *Grandidierella japonica*, and *Leptocheirus plumulosus*. EPA (1994b) has issued protocols for the testing using all of the five amphipods except *L. plumulosus*. Twenty-eight-day growth tests are under development for *G. japonica* and *A. abdita* (PRC 1995b,c).

Table 7-1 compares the habitat, salinity tolerance, sediment tolerance, and sensitivity to contaminants of four species of amphipods. *Rhepoxynius abronius*, a burrowing species, can tolerate salinities greater than 25 parts per thousand (ppt) but is sensitive to grain size (PRC 1994g; Long and Buchman 1989; MacDonald and others 1992). *Eohaustorius estuarius*, another burrowing species, can tolerate salinities ranging from 2 to 28 ppt and is not as sensitive to grain size as *R. abronius* (PRC 1994g; MacDonald and others 1992). *Ampelisca abdita* lives in burrows and is tolerant of salinities from 10 to 35 ppt and is not as sensitive to sediment grain size (PRC 1994g; MacDonald and others 1992). *Grandidierella japonica* also forms burrows, can tolerate salinities from 30 to 35 ppt, and lives in a variety of sediment types (MacDonald and others 1992).

Amphipods used in bioassays have been shown to differ in their level of sensitivity to contaminated sediments. Long and Buchman (1989) found *A. abdita* to be less sensitive than some of the other amphipods, including *R. abronius*. *Rhephoxynius abronius* is more sensitive to contaminants than *E.*

estuarius, which is more sensitive than *A. abdita* (Pastorok and Becker 1989; Flegal and others 1994). *Grandidierella japonica* is less sensitive than *R. abronius* (PRC 1994g). Based on a variety of studies, the relative level of sensitivity to various contaminants can be expressed as *R. abronius* > *E. estuarius* > *A. abdita*, with *A. abdita* very similar in sensitivity to *G. japonica*.

Both *A. abdita* and *G. japonica* occur at HPA; however, both are tube dwellers and therefore would not truly reflect sediment toxicity and are less sensitive than *E. estuarius*. *Eohaustorius estuarius* will be used to test the solid-phase toxicity at HPA because it burrows directly into the sediment, has a wide range of salinity tolerance, is relatively insensitive to grain size, and is highly sensitive to contaminants. In addition, there have been other contaminant studies in San Francisco Bay using *E. estuarius*, which can be used to evaluate the results at HPA (Long and Markell 1992). The amphipod test chosen for this study incorporates both lethal endpoint of mortality and sublethal endpoint of reburial.

7.1.2 Pore Water Bioassay

Pore water toxicity is often tested using either the bivalve larval development or the echinoderm fertilization or larval development bioassay. Both are sensitive tests; however, most bivalve species cannot be used year round because they are seasonally reproductive. The echinoderm *Strongylocentrotus purpuratus* is reproductively available year round, and thus the same species can be used at all times. For this study, pore water will be extracted from the solid-phase sediment and used in a 48- to 96-hour larval development test using the echinoderm *S. purpuratus*. The lethal endpoint of mortality and sublethal endpoint of abnormal development will be measured.

7.1.3 MICROTOX® Bioassay

The MICROTOX® test, which is quick and inexpensive, is being used on this project to obtain additional toxicity information from more stations than is cost effective using the amphipod and echinoderm bioassay tests. MICROTOX® measures the inhibition of light production by luminescent bacteria using the test organism *Photobacterium phosphoreum*. MICROTOX® compares favorably with other standard bioassays. Pastorok and Becker (1989), using a spearman rank correlation at a significance of $P \leq 0.01$, found a high correlation between MICROTOX® saline EC_{50} vs. each

endpoint in the *Rhepoxynius abronius* test (0.72 to 0.73). In addition MICROTOX® is very sensitive to contaminants. Louma and Ho (1993) found that 86 percent (196/227) of the MICROTOX EC_{50} was within an order of magnitude of the EC_{50} values from other bioassays. Pastorok and Becker (1990) found MICROTOX® (both saline and organic extracts) and the *Dendraster excentricus* (echinoderm) abnormality test to be generally the most sensitive bioassays to significant effects relative to responses to reference sediments. The order of sensitivity for sediment toxicity tests in sediment bioassessment of Halifax Harbour was MICROTOX® solvent extract > *Rhepoxynius abronius* > MICROTOX® pore water > *Corophium volutor* = *Neanthes* sp. (Tay and others 1992).

At present, there are four types of MICROTOX® tests: solid-phase (sensitive to grain size), saline extract of the solid-phase (removes water-soluble contaminants in pore water and adsorbed to sediment particles), organic extract of the solid-phase (removes nonionic aromatic and chlorinated hydrocarbons using an organic extract), and pore water extract.

The use of a straight pore water extract as the test media for this project is based on the following problems with the other MICROTOX® tests:

- Solid-phase test has confounding effects resulting from grain size
- Saline extract may underestimate the available metals
- Organic extract may have toxic effects from the extractant being used and may overestimate the available organics

Pore water will be extracted using the present method developed and used by EPA-Duluth and the National Biological Survey, and the U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, Columbia, Missouri.

7.1.4 Bioassay Sampling Locations

The three bioassays discussed above will be used to help characterize toxicity of offshore sediments. The solid-phase sediment using an amphipod, the pore water echinoderm development, and the pore water MICROTOX® bioassays will be conducted at 37 locations at HPA, including the reference stations, to determine the toxicity of sediment from HPA (Figures 6-1 to 6-4). The MICROTOX®

bioassay will also be performed at an additional 35 locations for comparison with the solid- and liquid-phase bioassays and to provide an estimate of toxicity of sediments at a greater number of stations.

7.1.5 Bioassay Testing Procedures

Solid-phase bioassays will be conducted and analyzed using the protocols specified by ASTM (1991) and EPA (1994b) (see Appendix A-1 of the QAPP). Data obtained from the 10-day bioassay test with *Eohaustorius estuarius* will include the number of initial burials, the daily number of emerged specimens, the percent reburials, and the number of mortalities as compared to the laboratory controls and the reference samples.

Pore water bioassays with the larval echinoderm, *Strongylocentrotus purpuratus*, will be conducted and analyzed using the protocols of EPA-Naragansett (EPA 1994b) and EPA/COE (1994) (see Appendix A-2 of the QAPP). Data obtained from the 48- to 96-hour test will include egg survival and incidence of larval abnormalities as compared to the laboratory controls and reference samples.

MICROTOX® bioassays will be performed on pore water using the methods outlined by ASTM (1995) and the Microbics Corporation (see Appendix A-3 of the QAPP). The toxicity endpoint is a decrease in bioluminescence and will be compared to the laboratory controls and reference samples.

7.1.6 Bioassay Data Analysis and Interpretation

Mean percent survival for the amphipod and mean percent larval survival and percent abnormality for the echinoderm will be calculated for laboratory control replicates, reference area replicates, and samples from the project site. Results from both bioassay tests will be statistically compared with reference and control sediments using parametric tests if assumptions are met, or suitable nonparametric tests. Assumptions of normality and equality of variances will be tested prior to analysis.

These statistical analyses will be used to determine whether results from sample areas are significantly different from reference and control area results. Statistical significance and biological significance

are not synonymous. A test may not be statistically significant but be biologically toxic and vice versa. Johnston and others (1994) report that an acute amphipod mortality of 20 percent or greater from the control has been shown to have a significant impact on amphipod population ecology. This value was based on a large number of acute amphipod tests using *Ampelisca abdita* for the National Status and Trends Program (PRC 1995b), and this level may vary somewhat with species (PRC 1995c). For this project, biological significance will be defined as that value with 20 percent or more mortality than the reference mean. Thus, a sample may not be statistically different from the control mean but be biologically significant by having a mean survival less than 80 percent of the reference mean (Table 7-2). This is a more conservative approach to minimize the chance of interpreting a location as "clean" when in fact it is not. This approach uses the mean as a primary criterion and statistical significance as a secondary criterion in interpreting bioassay test results.

The results of the MICROTOX® test are reported in terms of an inhibitory concentration, which is the calculated (or graphically determined) concentration of sample required to produce a specific quantitative light inhibition. Statistical methods used for the interpretation of the MICOTOX® test can be found in the ASTM guidelines (1995).

7.2 TISSUE RESIDUE STUDIES

Tissue residue samples will be collected mainly to assess the contaminant load being ingested by avian receptors feeding in the intertidal zone. These data will be used in the toxicity models described in Section 8.2. Invertebrate species and if available, fish species will be collected from 12 selected intertidal areas and the tissues analyzed to determine the contaminant body burdens. Tissue will be analyzed for the same suite of chemicals as the sediments. Figure 6-5 shows the tissue residue sampling locations. If a demersal fish with limited mobility cannot be identified for the intertidal area, then only invertebrates will be sampled. Invertebrate species will be pooled to get the required amount of biomass for chemical analysis; composite samples of this type would best represent the diverse avian diet. If sufficient biomass is not available from more than half of the areas to be sampled (12 areas), then sediment bioaccumulation tests will be conducted using intertidal sediments from the remaining areas.

7.2.1 Test Organisms

For each sampling site, two grab samples of sediments will be collected. Each sample will be sieved and the organisms collected. The organisms will be pooled, preserved, and sent to the laboratory for analysis.

7.2.2 Data Analysis and Interpretation

Tissue residue samples will be analyzed for trace metals, SVOCs, pesticides, PCBs, organotins, and TPH. Section 8.2 describes how the tissue residue results will be evaluated.

8.0 CHARACTERIZATION OF ECOLOGICAL RISK TO AQUATIC RECEPTORS

Risk characterization takes both the exposure data (solid-phase bulk sediment and liquid-phase pore water chemistry) and effects data (toxicity tests) and combines the two to estimate risk. The exposure and effects data to be collected are discussed in Sections 6.0 and 7.0, respectively. Two models have been developed to evaluate risk to aquatic receptors. The first evaluates the risk to benthic receptors (Section 8.1) and the second evaluates risk to avian receptors that feed in the aquatic environment (Section 8.2).

8.1 CHARACTERIZATION OF RISK TO BENTHIC RECEPTORS

The risk assessment will use sediment chemistry measurements, sediment pore water measurements, sediment parameters that directly affect bioavailability (pH, AVS/SEM, TOC, grain size), and bioassays (Sections 6.0 and 7.0). These data, using a weight-of-evidence approach, will be used to estimate the quantitative probability of adverse effects that a particular location may have on benthic receptors.

Risk will be analyzed in steps as presented in Figure 8-1 and described below:

Step 1: Sediment chemistry and sediment pore water results will be screened against the screening criteria discussed in Section 6.4.3.

Step 2: HQs will be developed for each chemical using agreed-upon screening criteria and summed at each station to provide a station-specific HI for contaminants having similar chemistry and toxicological modes of action. If the HI is greater than 1, then the location poses a potential risk for benthic receptors. An HI less than 1 would indicate that the location does not pose a risk to benthic receptors and no further action is required at that location.

Step 3: Correlation analysis will be performed on the measured parameters (total sediment HIs and pore water HIs versus toxicity tests) to evaluate if the observed toxicity can be explained by the correlated parameters at that station location.

Step 4: The risk associated with all sampling locations will be evaluated using the weight-of-evidence approach. If a positive correlation (correlation coefficient > 0.5) between HI and toxicity test results is found, the HI will be considered to correlate with toxicity. Stations without direct toxicity tests could then be evaluated using only the HI with greater confidence.

Step 5: Based on the result of the weight-of-evidence approach, all stations will be ranked in relation to each other and the reference station into three categories of risk: low, medium, or high.

8.2 CHARACTERIZATION OF RISK TO AQUATIC AVIAN RECEPTORS

This section describes the methods to be used to characterize the potential risk posed to aquatic avian assessment endpoints (those feeding in the aquatic environment) by contamination in the offshore environment of HPA. In order to characterize risks to receptors at a hazardous waste site, some measurements of toxicity and community structure are necessary. However, for many of the wildlife species at HPA, direct toxicity testing and community analysis are not practical. All of the assessment endpoints at HPA are species native to California, and some are of special conservation concern, making direct tissue sampling undesirable. For example, direct tissue sampling of benthic invertebrates and fish is practical, since these species are commonly harvested. On the other hand, tissue sampling is not recommended for shorebirds and raptors because of conservation concerns. For aquatic avian receptors which are not available for direct tissue measurement, the route, magnitude, duration, and frequency of exposure will be analyzed by developing receptor-specific exposure models.

This section is divided into three subsections: Section 8.2.1 describes the methodology for the exposure assessment; Section 8.2.2 describes the methodology for the ecological effects assessment; and Section 8.2.3 describes the methodology for the data analysis and interpretation for risk

characterization.

8.2.1 Exposure Assessment: Exposure Modeling

This section describes the exposure models that will be used to identify the degree of exposure to contaminants experienced by aquatic avian assessment endpoints. The exposure models will estimate the mass of a chemical internalized daily by a receptor per kilogram of body weight (daily chemical dosage). The principal routes of exposure are ingestion, inhalation, and dermal contact. For this phase of the risk assessment at HPA, exposure through ingestion of sediment and prey will be evaluated quantitatively; exposure through inhalation or dermal contact will be evaluated qualitatively.

Appropriate estimates of exposure are generally based on knowledge of the spatial and temporal distribution of both contaminants and receptors, exposure patterns, bioavailability, and specific natural and life history characteristics that influence exposure to contaminants. For each COPC and receptor, a daily chemical dosage will be estimated, which will then be compared to a toxicity reference value (TRV) to identify the potential adverse biological effects experienced by the receptor. Based on this comparison, the risk to each assessment endpoint will be characterized.

The total exposure from ingestion for each receptor of concern will be calculated as the sum of the dietary and soil (or sediment) exposure estimates. The following generic equation will be customized for each aquatic avian assessment endpoint.

$$Dose_{total} = \frac{[(IR_{prey} \times C_{prey}) + (IR_{soil} \times C_{soil})] \times ED \times SUF}{BW}$$

where:

$Dose_{total}$	=	Estimated dose from ingestion (milligrams per kilogram[mg/kg] body weight-day)
IR_{prey}	=	Amount of prey ingested (mg/kg-day)
C_{prey}	=	Concentration of contaminant in prey (mg/kg)
IR_{soil}	=	Amount of soil ingested (mg/kg-day)
C_{soil}	=	Concentration of contaminant in soil (mg/kg)
ED	=	Exposure duration (fraction of year spent at HPA) (unitless)
SUF	=	Site use factor (unitless)
BW	=	Body weight (kg)

The basic components of the exposure models are (1) temporal and spatial characterization of receptors; (2) ingestion rates and diet composition; (3) life history and behavioral information; (4) dose estimates resulting from exposure model calculations. The specific parameters associated with these components are addressed in the following subsections.

8.2.1.1 Temporal and Spatial Characteristics

Seasonal activities, habitat preference, and the feeding behavior of a receptor, as well as spatial variation in contaminant distribution, can influence the exposure of a receptor to contaminants. To account for the seasonal use of habitat at HPA, an exposure duration (ED) factor will be calculated. An ED value of 1 will be used for receptors of concern that are year-round residents of the assessment area, and a value between 0 and 1 will be used for migratory species based on the fraction of the year spent in the region. The ED factor will be developed primarily from site-specific or regional information and secondarily from available literature.

In addition to seasonal factors, a receptor's exposure is influenced by the likelihood of using the habitat in which contamination is found. One measure of habitat use is indicated by the receptor's home range. That is, species with comparatively large home ranges relative to the area of contamination may be exposed less than those with small home ranges. However, standard estimates of home ranges in the published literature may need to be modified for exposure assessment. Home range generally includes the total area in which an animal spends some amount of time during a certain season, including breeding, foraging, roosting, and travel routes (Lincoln and others 1982). A further complication is that home ranges can vary by gender, reproductive condition, and size of the animal, as well as by season and other dynamic factors. A more appropriate comparison may be the size of the animal's foraging area with the area of contamination if the primary exposure pathway is ingestion. A site use factor (SUF) will be developed for each receptor based on the following ratio:

SUF = Area of contamination (acres)/Area of potential exposure (acres)

where Area of contamination (AC) = areal extent of contamination by a single contaminant

and Area of potential exposure (APE) = area used by the receptor in a way that represents exposure, such as foraging, digging, or other use

The SUF will be reported as a proportion, with any values greater than unity being converted to 1.0; values less than 1.0 will be reported directly. The SUF will be used in the exposure model equation presented in Section 8.2.1. The AC will be measured by drawing contaminant contours on the site maps for each COPC. For the exposure estimate, two contours will be drawn: (1) "Low" - concentrations between ER-L and ER-M and (2) "High" - concentrations exceeding ER-M. The area within each contour will be digitized and quantified as a proportion of the total offshore habitat at HPA.

To arrive at a more accurate estimate of site use, two estimates of the SUF will be calculated, one using the "Low" AC and one using the "High" AC. These two estimates will result in different daily dose estimates. Estimates of exposure to the receptor will be based on the proportion of the habitat that falls into the "Low" and "High" concentration areas compared to the area used by the receptor. For example, if a kestrel's foraging range extends across the marsh habitat, and the "Low" AC represents 40 percent of the habitat, then the daily dose estimate for the kestrel would be the sum of 40 percent of the "Low" dose and 60 percent of the "High" dose.

Based on the results of the bioassay, bioaccumulation, and tissue residue measurements (as described in Section 6.0 and 7.0), hot spots in the offshore environment of HPA will be defined. Assessment endpoint usage of these hot spots will be analyzed to identify the potential coincidence of high contaminant concentrations and receptor feeding sites. SUFs for each receptor will be modified according to this information to accurately reflect receptor exposure.

8.2.1.2 Ingestion Rate and Diet

Ingestion is a route of exposure that may involve many different media, most commonly food, water, soil, and sediment. While the diet content and ingestion rate may vary seasonally, in general, a receptor's ingestion rate can be defined as a function of its metabolic rate and body size. When available, regional information will be used to estimate the body weight and amount of food a receptor ingests. Literature values or allometric regression models (EPA 1993a,b) will be used to estimate ingestion rates if regional information is lacking.

Diet composition may be affected by changes in season, availability of prey or forage, reproductive condition, individual variation, and many other factors. Since this variability is not easy to incorporate into an exposure model, average estimates will be used as much as possible. For year-round resident species for which seasonal data are available, diet composition will be averaged over seasons. For migratory species, diet appropriate to the season of the year they are present in the region will be used. In some cases, it will be necessary to make conservative assumptions because of the availability of information and model constraints. These conservative assumptions would result in over-estimates of exposure.

Contaminant tissue concentrations of prey species likely to be significant exposure routes for aquatic avian assessment endpoint taxa will be measured. These tissue concentrations will be used in the exposure model. Direct measures of contaminant concentration in prey will reduce the amount of uncertainty associated with the use of bioaccumulation factors extrapolated from the literature. Proposed prey species to be collected are presented in Section 7.0 and in Table 4-2.

Many wildlife species ingest soil or sediment while feeding or preening; however, actual ingestion rates are known for only a few species (Beyer and others 1994; Arthur and Gates 1988). For some receptors, ingestion of contaminated soil or sediment may constitute a significant portion of the total dietary exposure to contaminants. In a study of soil ingestion by wildlife through analysis of the acid-insoluble ash content of scat, Beyer and others (1994) demonstrated that sandpipers had the greatest estimated percentage of soil/sediment in their diets (7.3 to 30 percent). Estimates of incidental ingestion of soil or sediment will be gathered from the scientific literature for each assessment endpoint, and appropriate values will be used in the exposure model. Because estimated soil/sediment ingestion rates are only known for a few species, rates may be approximated or extrapolated from another species.

8.2.1.3 Life History and Behavioral Information for Exposure and Risk Analysis

As discussed above, several life and natural history characteristics of receptors influence exposure to contamination and must be incorporated into the exposure model for an assessment endpoint. These characteristics include diet composition, ingestion and metabolic rates, body weight, foraging range, seasonal presence at the site, feeding behavior, reproductive behavior, and others. For each aquatic

avian assessment endpoint, detailed data on relevant life and natural history characteristics influencing exposure and risk will be collected and used in the risk characterization. Data will be obtained through literature reviews and consultation with other sources of information, including the following.

- Golden Gate Raptor Observatory
- Point Reyes Bird Observatory
- California Academy of Sciences
- U.S. Fish and Wildlife Service
- California Department of Fish and Game
- University of California Libraries
- Wildlife Habitat Relational System
- EPA's Wildlife Exposure Factors Handbook (1993a,b)
- National Biological Survey's Raptor Management Information System

Data from the San Francisco Bay region and California will be preferred over data from other locations. Data will be specific to the assessment endpoint receptors and will be from studies conducted in habitats similar to those found at HPA.

To clearly present data that will be used to estimate exposure model parameters, a table will be developed for each assessment endpoint that presents the best data available from the scientific literature for each exposure model parameter. From these data, specific values for each parameter will be selected for use in calculating the receptor's dose. The reasons for selecting the specific values for each exposure model parameter from the range of those possible will be explained. A blank version of the table to be developed for each assessment endpoint receptor is presented as follows:

Body Weight	**Home Range/ Area of Potential Exposure**	**Exposure Duration**	**Incidental Ingestion of Soil or Sediment**	**Dietary Proportion of Prey of Interest**

8.2.1.4 Dose Estimates Resulting from Exposure Model Calculations

Every effort was made both to tailor assumptions to conditions at HPA and to reduce uncertainty. Nevertheless, sources of uncertainty, both known and unknown, are unavoidable in ecological modeling. Limited availability of natural history data applicable to the conditions at HPA may result in uncertainty in dose estimates. Other sources of uncertainty may result from inappropriate assumptions concerning bioavailability, diet proportions of receptors, food chain transfer, and other biological and physical factors and processes influencing exposure and toxicity at HPA. For these reasons, two estimates of dose will be calculated, low and high, to identify a range of possible doses. Both of these estimates will use reasonably conservative values from appropriate literature based on habitat, taxa, exposure route, and other relevant ecological factors. Prey tissue residues to be included will be from prey expected to have the highest potential exposure to contaminants. The following assumptions apply to values in exposure model parameters in estimates of low and high doses.

High dose estimates will follow these principles:

- Use the *lowest* body weight found in the literature
- Use the *lowest* estimate of home range found in the literature
- Assume *100 percent* of the diet is composed of the prey species for which there is tissue residue data (an uncertainty factor may be used if necessary)
- Assume exposure duration is *all year* or a *lifetime*
- Designate incidental ingestion of soil or sediment as *one and one- half times* the mean of the percentage of soil or sediment reported in the literature
- Use the *lower* of either the 95 percent upper confidence interval of the mean or the maximum concentration as the concentration of the COPC in soil or sediment

Low dose estimates will follow these principles:

- Use the *highest* body weight found in the literature
- Use the *highest* estimate of home range found in the literature

- Assume *50 percent* of the diet is composed of the prey species for which there is tissue residue data
- Assume exposure duration of exposure is the *minimum reported*
- Designate incidental ingestion of soil or sediment as *half* of the mean of the percentage of soil or sediment reported in the literature
- Use the *mean* concentration as the concentration of the COPC in soil or sediment

These estimates of dose will be used in the effects assessment and risk characterization as described in Section 8.2.2.

8.2.2 Effects Assessment For Aquatic Avian Assessment Endpoints: Toxicity Reference Values

The purpose of the ecological effects assessment is to characterize the possible ecological effects on assessment endpoints resulting from exposure to COPCs. For each aquatic avian assessment endpoint and offshore COPC, HQs will be calculated by comparing the doses estimated from the quantitative exposure model for that endpoint with appropriate TRV. The TRV represents a critical exposure level from the best available toxicological studies. The methodology for TRV development is discussed in the following subsections.

8.2.2.1 Toxicological Data for TRV Development

In Task 4.0 of the Phase 1A ecological assessment for HPA, a brief toxicological profile, including toxic effect and fate and transport data, was presented for each COPC. Data consisted of a variety of no-observed-effect level (NOEL), lowest-observed-effect level (LOEL), lowest-observed-adverse-effect level (LOAEL), and no-observed-adverse-effect level (NOAEL) concentrations, lethal concentration and lethal dosage values (LC_{50} and LD_{50}), and other sublethal, chronic, and acute-effect level concentrations. A more comprehensive literature search focused on COPCs and assessment endpoints in the offshore environment of HPA will be conducted to form a core toxicological data set from which TRVs will be derived. The following criteria will be used in selecting data for TRV derivation:

- Experimental taxa should be as similar as possible to receptor species at HPA with respect to taxonomy, body size, and feeding habits and behavior.
- Test exposure routes and media should be similar to those expected in the field.
- Endpoints related to reproduction, growth, and mortality are preferred since they best reflect population impacts.
- Chronic exposures and responses and NOEL data will be preferred.
- The study design must be of high quality, with adequate sample size, explicit analysis of experimental uncertainty, and well justified conclusions.

Mortality is not an appropriate endpoint in toxicological studies for use in ecological risk assessment, since detrimental effects on populations and ecosystems can occur at chemical concentrations much lower than those causing mortality. Also, the high degree of uncertainty involved in estimating a NOEL from a lethal dose or concentration reduces the useability and certainty of the converted data. Therefore, toxicological data having mortality as an endpoint will be used only if no other data are available or if the data are on an assessment endpoint receptor.

Sources of data on ecological effects include:

- Primary literature (scientific publications)
- Agency for Toxic Substance and Disease Registry
- U.S. Fish and Wildlife Service Contaminant Hazard Reviews
- Hazardous Substance Databank
- Integrated Risk Information System
- AQUIRE (a database of results of toxicity tests conducted in water on aquatic species)
- ECOTOX (a database of toxicity data compiled for terrestrial receptors; to be used when available)

The following sections discuss the methodology for deriving TRVs from these data.

8.2.2.2 Derivation Of TRVs

The toxicological literature search will produce a core set of data most applicable to the development of a TRV for each aquatic avian assessment endpoint receptor and offshore COPC at HPA. Because of the limited availability of toxicological data on COPCs and receptors of concern at HPA, the core data set may contain studies on a variety of test species of various ages and sexes, examining a variety of endpoints, effects, and exposure durations. Consequently, literature values may need to be converted to chronic, NOEL equivalents for the receptor and COPC being addressed. Such conversions generally result in chronic, NOEL equivalents for receptors of concern and add uncertainty to the accuracy of the TRV.

Several studies were reviewed to investigate possible methodologies for deriving TRVs (Calabrese and Baldwin 1993; Opresko and others 1993; EPA 1993a,b). Figure 8-2 is a flow-chart describing some possible conversions that a literature toxicity value may be subject to in the estimation of a TRV. Conversions depicted in Figure 8-2 involve the application of uncertainty factors to extrapolate from low-effect level or mortality to NOEL and from acute to chronic exposures and the use of allometric conversion to extrapolate effects between different species. Published methods for conducting ecological assessments differ on the magnitude and type of uncertainty factors recommended in such conversions (Opresko and others 1993; Suter 1993; Calabrese and Baldwin 1993). Similarly, researchers differ on the use of allometry to extrapolate between effects on different species. Allometric conversions may be inappropriate for extrapolation between species having large phylogenetic differences or even between closely related species, if they have different feeding behaviors, habits, or physiology.

Because of these confounding factors and because the availability and type of toxicological data on COPCs and receptors of concern is not currently known, the exact numbers used as uncertainty factors, the conditions for their use, and the conditions for use of allometry will not be detailed at this time. Rather, these conversion factors will be defined after the core toxicological data set used to derive TRVs is identified, presented, and discussed with the regulatory agencies. In this way, needed conversions will be defined based on the actual data to be used. When appropriate uncertainty factors and allometric conversions are identified, they will be presented in a flow chart similar to that in Figure 8-2.

Because of the uncertainties discussed above in calculations of TRVs, a low and high TRV will be derived for each aquatic avian assessment endpoint and COPC. A TRV will be derived from each toxicity value in the core data set, applying uncertainty factors and allometric conversions as necessary. The resulting TRVs will be ordered numerically. Low and high TRVs will be selected from the range of calculated TRVs based on quality of the original data, endpoints measured, test species, exposure duration, uncertainty factors and allometric conversions applied, and the size of the numerical range of TRVs. The low TRV is a conservative value thought to be the closest to a chronic NOEL; the high TRV is a less conservative effect level that is still thought to be relatively protective of the receptor of concern. When possible, the highest NOAEL and the lowest LOAEL on a single effect and organism derived in one study will be used as the high and low TRVs, respectively.

A TRV data table will be presented for each offshore COPC and aquatic avian assessment endpoint, as follows, to demonstrate how each toxicity value was converted into a TRV. The reasons for the selection of the low and high TRVs will be clearly documented.

Raw Toxicological Data					**UFs Applied**	**Allometric Conversions Applied**	**Final TRV**
Test organism	**Dose (mg/kg bw-day)**	**Exposure Duration**	**Endpoint**	**Effect**			

8.2.3 Data Analysis And Interpretation

Risk to aquatic avian assessment endpoints will be characterized by calculating an HQ. HQs will be calculated by dividing low and high dose estimates by low and high TRVs, resulting in four HQs for each COPC and receptor. Calculating a range of HQs will allow a greater range of possible risks to be identified than would be possible if only one HQ was calculated, since the extremes are defined.

$$HQ = \frac{Dose}{TRV}$$

As explained in regulatory guidance (EPA 1989), receptors may experience risk from exposure to a COPC if the HQ exceeds one. The eight possible results of the HQ calculations are presented in the matrix below. Analysis of risk through exposure of assessment endpoint receptors to each COPC will be based upon this matrix.

HQ = Dose / TRV	**Low TRV**	**High TRV**
Low Dose	HQ $\leq$ 1 $\Rightarrow$ Risk? HQ > 1 $\Rightarrow$ Risk?	HQ $\leq$ 1 $\Rightarrow$ Risk? HQ > 1 $\Rightarrow$ Risk
High Dose	HQ $\leq$ 1 $\Rightarrow$ No Risk HQ > 1 $\Rightarrow$ Risk?	HQ $\leq$ 1 $\Rightarrow$ Risk? HQ > 1 $\Rightarrow$ Risk?

The best-case scenario, represented by the situation in which the HQ calculated using the higher dose and the lower TRV is less than or equal to one, would indicate no risk for exposure of the receptor to that COPC. These cases would be recommended for "no further action" (NFA) based on that COPC and that receptor. If all COPCs and assessment endpoints for a site fall into this category, the whole site would be recommended for NFA. The worst-case scenario, represented by the situation in which the HQ calculated using the lower dose and the higher TRV is greater than one, would indicate a high likelihood of risk to that receptor resulting from exposure to that COPC. These are the two most clear-cut risk decision criteria, with the least uncertainty.

Calculated HQs falling in the other six categories are not amenable to simple distinctions of risk. For these situations, to identify the potential for risk due to exposure of a receptor to a COPC, the following will be evaluated using a weight-of-evidence approach: the HQ values, the assumptions used in the exposure model, and the quality of the data used in the exposure model and the derivation of the TRVs.

Most wildlife species in natural systems are exposed to more than one contaminant at any given time, so the cumulative effects of exposure to several contaminants (that is, synergy, additivity, antagonism)

must be considered. Aside from a few laboratory studies where multiple exposures have been tested, little is known of how multicontaminant exposure influences the responses of wildlife to toxic substances. The potential combined effects of toxic substances to which wildlife species are simultaneously exposed, particularly at chronic levels, is related to physiological function and reproduction (Peterle 1991). In addition, other physical, social, behavioral, nutritional, and human-induced disturbances impact individuals and populations at HPA.

Potential risks from multiple-contaminant stressors will be characterized using the HI approach for those assessments evaluated through exposure and effects modeling. Contaminants having similar chemistry and toxicological modes of action will be grouped and their HQs summed to calculate an HI for each contaminant group. These HIs will provide a qualitative evaluation tool for identifying risks due to exposure to multiple-contaminant stressors.

9.0 SCREENING OF POTENTIAL EXPOSURE AND EFFECTS IN THE TERRESTRIAL ENVIRONMENT

The following sections describe the methods to be used to characterize the potential risk posed to terrestrial receptors (those feeding in terrestrial habitats). As described in Section 3.1.1, COPCs were identified for the terrestrial environment by comparison with the RWQCB basin plan soil levels protective of marine water quality objectives. This comparison alone is insufficient for identification of COPCs in the terrestrial environment because the RWQCB basin plan soil levels were designed for protection of aquatic organisms and do not consider terrestrial receptors. However, because there are currently no upland soil screening criteria approved by the San Francisco Bay area regulatory community, additional methods must be used to screen existing soil chemistry data for potential exposure and effects in the terrestrial environment. The potential for terrestrial receptors to experience adverse effects resulting from exposure to contaminants at HPA will be evaluated using the exposure and effects models described below.

Based on the conceptual site models and the food webs for HPA, exposure scenarios were analyzed for each parcel. Based on these models, Parcels B, C, and D were considered to pose *de minimis* risk to terrestrial receptors. These parcels are significantly industrialized and developed, support significant human activity, and support few terrestrial receptors of concern. Parcel A also is

considered to pose *de minimis* risk to terrestrial receptors based on the qualitative screening ecological risk assessment written by the U.S. EPA (1994a). Therefore, the screening assessment of exposure to and effects on terrestrial receptors will be performed in Parcel E only.

COPCs in soils and terrestrial receptors will undergo a screening assessment to model contaminant exposure and effects based on existing soil data. Potential risks posed by ingestion of inorganic, non-bioaccumulative compounds will be assessed using an exposure and effect model based on small mammals. Potential risks posed by ingestion of bioaccumulative organic and inorganic compounds will be assessed using an exposure and effect model based on the American kestrel. These two models are conceptually similar to (although simpler) than those discussed in Section 8.2. These screening models estimate dose based on concentrations of contaminants in soil, rather than on tissue residue data. The models are described in the following two sections.

9.1 SCREENING ASSESSMENT FOR INORGANIC, NON-BIOACCUMULATIVE COMPOUNDS BASED ON SMALL MAMMALS

Exposure of terrestrial receptors to inorganic and nonbioaccumulative compounds at Parcel E will be evaluated based on risk to small mammals modeled using the following equation. This model will not use tissue residue data to estimate dose, but rather will estimate dose based on soil contaminant concentrations. Exposure to all terrestrial taxa potentially exposed to nonbioaccumulating contaminants will also be estimated using the model shown below. The conservative daily dose of each nonbioaccumulating COPC ingested by a small mammal inhabiting Parcel E will be compared to TRVs to identify potential risks.

$$Dose = \frac{IR_{total} x C_{soil}}{BW}$$

where:

Dose	=	Total mass of COPC ingested per unit body weight per day (mg/kg-day)
IR_{total}	=	Total ingestion rate (sum of ingestion rates of soil and prey) (mg/day)
C_{soil}	=	Concentration of COPC in soil (mg/kg)
BW	=	Body weight (kg)

The model will include the following assumptions to arrive at a conservative estimate of dose:

1. Exposure duration is 100 percent of lifetime.
2. Contaminants are 100 percent bioavailable.
3. The receptor's food contains the same concentration of contamination as that in soil.
4. All soil is contaminated at concentrations equaling the maximum detected concentration.

Because no direct measurements of exposure will be used in this model, conservative assumptions and values will be selected as parameters in the exposure model. The validity of the assumptions made in the exposure model will be evaluated based on the data gathered for each model parameter. Based on this evaluation, the model may be modified to tailor assumptions and data more closely to the conditions at HPA. This may involve calculation of low and high estimates of dose analogous to those discussed in Section 8.2.2.

The dose estimate will be directly compared to a TRV for rodents. One TRV will be derived using the same methods as those described in Sections 8.2.2. To implement a conservative screening, this TRV will be equivalent to the low TRV described in Section 8.2.2. This model is designed to evaluate potential risks occurring at low trophic levels in the terrestrial food web; the TRVs selected will be consistent with that goal.

Ingestion rates and body weights of small mammals will be obtained from scientific literature. The criteria described in Section 8.2.2 to select natural history data for use in exposure model parameters will also be applied in this screening assessment.

If the dose estimate for a COPC exceeds the TRV, then that COPC will be recommended for further investigation in later phases of this ecological assessment. Potential further investigations are described in Section 9.3. If the dose estimate for a COPC does not exceed the TRV, then that COPC will be eliminated from further consideration under the ecological assessment of Parcel E.

9.2 SCREENING ASSESSMENT FOR BIOACCUMULATIVE ORGANIC AND INORGANIC COMPOUNDS BASED ON THE AMERICAN KESTREL

All terrestrial receptors and bioaccumulative and organic and inorganic COPCs for which a complete exposure pathway may exist at Parcel E will be evaluated using an exposure and effects model based

on the American kestrel (*Falco spaverius*), as shown in the following equation. This model will not use tissue residue data to estimate dose, but rather will estimate dose based on soil contaminant concentrations. Exposure to all terrestrial taxa potentially exposed to bioaccumulating contaminants will be estimated using the model shown below. The conservative daily dose of each bioaccumulating COPC ingested by a kestrel inhabiting Parcel E will be compared to a TRV to identify potential risks.

$$Dose = \frac{[IR_{prey} \times BMF \times C_{soil}] + [IR_{soil} \times C_{soil}]}{BW}$$

where:

Dose	=	Total mass of COPC ingested per unit body weight per day (mg/kg-day)
IR_{prey}	=	Ingestion rate of prey (mg/day)
C_{soil}	=	Concentration of COPC in soil (mg/kg)
IR_{soil}	=	Ingestion rate of soil (mg/day)
BW	=	Body weight (kg)
BMF	=	Biomagnification factor (unitless)

The model will include the following assumptions in order to arrive at a conservative estimate of dose:

1. Exposure duration is 100 percent of lifetime.
2. Contaminants are 100 percent bioavailable.
3. The prey of the kestrel biomagnifies food at the magnitude indicated by scientific literature.
4. All soil is contaminated at concentrations equaling the 95 percent upper confidence limit of the mean or the maximum detected concentration.

The dose estimate will be directly compared to a TRV for the American kestrel. One TRV will be derived using the same methods as those described in Sections 8.2.2. To implement a conservative screening, this TRV will be equivalent to the low TRV described in Section 8.2.2. This model was designed to predict potential adverse effects occurring at high trophic levels in the terrestrial food web, and the TRVs selected will be consistent with that goal.

The ingestion rate and body weight for the American kestrel will be obtained from scientific literature, and the same ingestion rate will be used in the model for each COPC. The criteria described in Section 8.2.2 to select natural history data for use in exposure model parameters will be

applied in this screening assessment.

Because no direct measurements of exposure will be used in this model, conservative assumptions and values will be selected as parameters in the exposure model. The validity of the assumptions made in the exposure model will be evaluated based on the data gathered for each model parameter. Based on this evaluation, the model may be modified to tailor assumptions and data more closely to the conditions at HPA. This may involve calculation of low and high estimates of dose analogous to those discussed in Section 8.2.1.4.

If the dose estimate for the COPC exceeds the TRV at Parcel E, then that COPC will be recommended for further investigation in later phases of this ecological assessment (see Section 9.3). If the dose estimate for the COPC does not exceed the TRV, then that COPC will be eliminated from further consideration under the ecological assessment of Parcel E.

9.3 FURTHER INVESTIGATION OF POTENTIAL RISK TO TERRESTRIAL RECEPTORS IN PARCEL E

If the results of the screening assessment described in Sections 9.1 and 9.2 indicate potential risk to small mammal or raptor species (as represented by the American kestrel) due to exposure to contaminants at Parcel E, further investigations will be performed to characterize the likelihood and nature of the potential risk (Table 9-1). These further investigations will consist of a more detailed modeling of exposure to terrestrial receptors similar to that proposed for aquatic avian receptors.

Further investigations would include measurement of contaminant concentrations of terrestrial small mammal prey species. Tissue residue data would be applied in the exposure and effects model as detailed in Section 8.2 in order to model potential adverse effects on the terrestrial assessment endpoint, the American kestrel. For example, for the American kestrel, a small mammal species such as the California vole (*Mictrotus californicus*) would be selected for tissue residue measurement. Prey species for which tissue residue may be analyzed are listed in Table 9-1. Appropriate prey species will be selected based on occurrence and abundance at HPA and on prey preferences indicated in the scientific literature.

The tissue residue measurements would also be used to evaluate potential direct impacts to small mammals resulting from exposure to contaminants. The tissue residues will be compared with body and organ burdens thought to indicate exposure or adverse effects as published in the scientific literature. Small mammals may be trapped to identify species living at HPA.

10.0 PREPARATION OF REPORTS

In conjunction with this work plan, an FSP has been developed to provide specific details of the field investigation. In conjunction with the FSP, a QAPP and health and safety plan are other companion documents prepared that support the Phase 1B ERA.

A final report will be prepared following completion of the Phase 1B ERA. This report will discuss the sampling and testing methodologies, data collected, statistical methods, evaluation of the data, findings and conclusions, and recommendations for further work if necessary.

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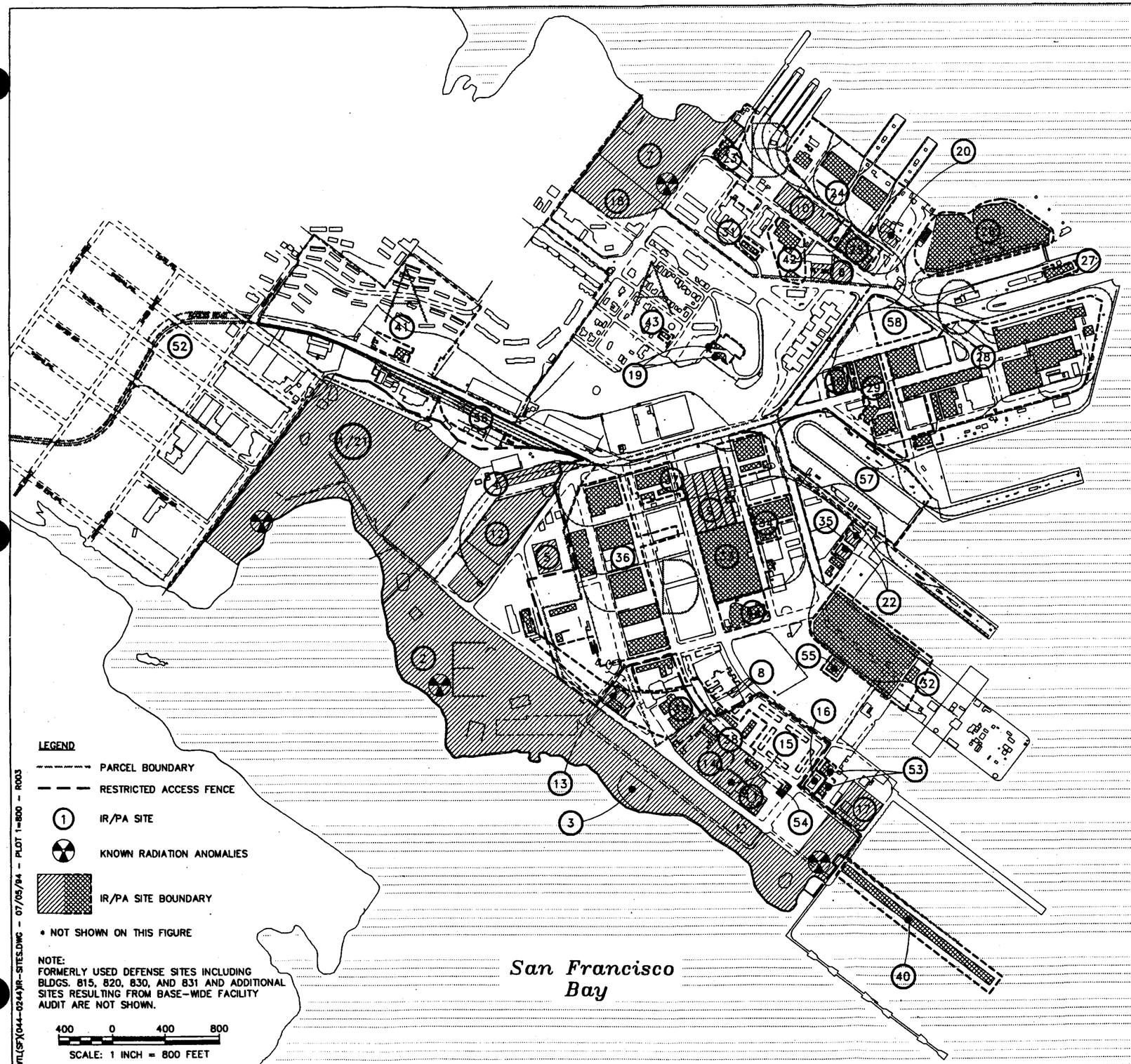
FIGURES



SCHEDULE

Parcel A

- 19 BLDG. 901
- 41 BLDGS. 816 AND 818
- 43 BLDG. 906

Parcel B

- 6 TANK FARM
- 7 SUB-BASE AREA
- 10 BATTERY AND ELECTROPLATING SHOP (BLDG. 123)
- 18 WASTE OIL DISPOSAL AREA
- 20 BLDG. 156
- 23 BLDGS. 146, 161, AND 162
- 24 BLDGS. 124, 125, 128, AND 130
- 25 BLDG. 134
- 26 BLDG. 157, AREA XIV
- 31 BLDG. 114
- 42 BLDGS. 109 AND 113
- 46* FUEL DISTRIBUTION LINES, TANK FARM

Parcel C

- 27 BLDGS. 205
- 28 BLDGS. 211/253, 219, 230, 231, 258, 270 271, AND 281
- 29 BLDGS. 203, 217, 275, 279, 280 AND 282
- 30 BLDG. 241
- 57 DRYDOCK 4 AREA
- 58 SCRAP YARD NEAR BLDGS. 258

Parcel D

- 8 PCB SPILL AREA
- 9 PICKLING AND PLATE YARD
- 16 CONTAINER STORAGE AREA
- 17 DRUM STORAGE AND DISPOSAL AREA
- 22 BLDGS. 368 AND 369
- 32 BLDG. 383, REGUNNING PIER
- 33 BLDGS. 302, 302A, 304, 364, 411 AND 418
- 34 BLDGS. 351 AND 366
- 35 BLDGS. 274 AND 306, AND AREA BOUNDED BY MANSEAU, MORELL, AND E STREETS
- 36 BLDGS. 371, 400, 404A, 405, 406, 413, 414, 704, AND 710 AND AREA WEST OF BLDG. 405
- 37 BLDGS. 401, 423, 435, AND 436
- 44 BLDG. 438 AND AREA NEAR BLDGS. 408, 409, AND 410
- 48* SUSPECTED STEAM LINES FORMER BLDG. 503
- 53 BLDGS. 525 AND 530
- 55 BLDG. 307

Parcel E

- 1/21 INDUSTRIAL LANDFILL
- 2 BAY FILL AREA
- 3 OIL RECLAMATION PONDS
- 4 SCRAP YARD
- 5 OLD TRANSFORMER STORAGE YARD
- 11 BLDGS. 521, POWER PLANT AREA
- 12 DISPOSAL TRENCH AREA
- 13 OLD COMMISSIONARY AREA
- 14 OILY LIQUID WASTE DISPOSAL AREA
- 15 OILY WASTE PONDS AND INCINERATION TANK
- 40 BLDGS. 527 AND PIER 2
- 47* FUEL DISTRIBUTION LINES, TANK S-505
- 52 RAILROAD RIGHT-OF-WAY
- 54 BLDG. 511A
- 56 AREA VII, RAILROAD TRACKS

Parcels A,B,C,D,+E

- 45* STEAM LINES
- 50* STORM DRAIN AND SANITARY SEWER LINES
- 51* FORMER TRANSFORMER SITES

Parcels B+C

- 49* FUEL DISTRIBUTION LINES BLDGS. 203 AND 205

Parcels D+E

- 38 BLDGS. 500, 506, 507, 509, 510 AND 517
- 39 BLDGS. 505 AND 707

LEGEND

- PARCEL BOUNDARY
- RESTRICTED ACCESS FENCE
- (1) IR/PA SITE
- KNOWN RADIATION ANOMALIES
- IR/PA SITE BOUNDARY
- * NOT SHOWN ON THIS FIGURE

NOTE:
FORMERLY USED DEFENSE SITES INCLUDING BLDGS. 815, 820, 830, AND 831 AND ADDITIONAL SITES RESULTING FROM BASE-WIDE FACILITY AUDIT ARE NOT SHOWN.

400 0 400 800
SCALE: 1 INCH = 800 FEET

WTL(SF)(044-0244)IR-SITES.DWG - 07/05/84 - PLOT 1=800 - R003

FIGURE 2-1
FACILITY LAYOUT
HUNTERS POINT ANNEX

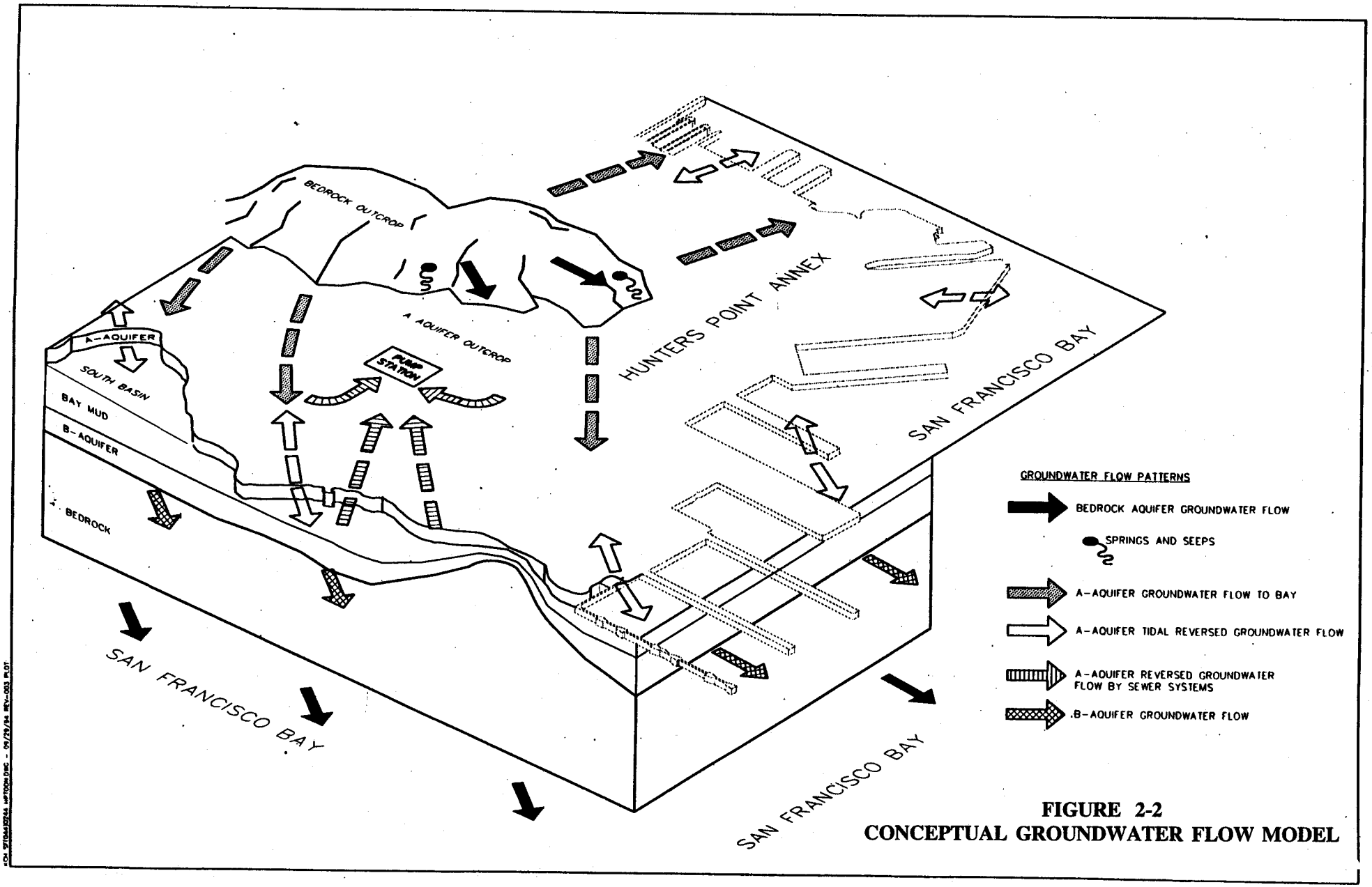


FIGURE 2-2
CONCEPTUAL GROUNDWATER FLOW MODEL

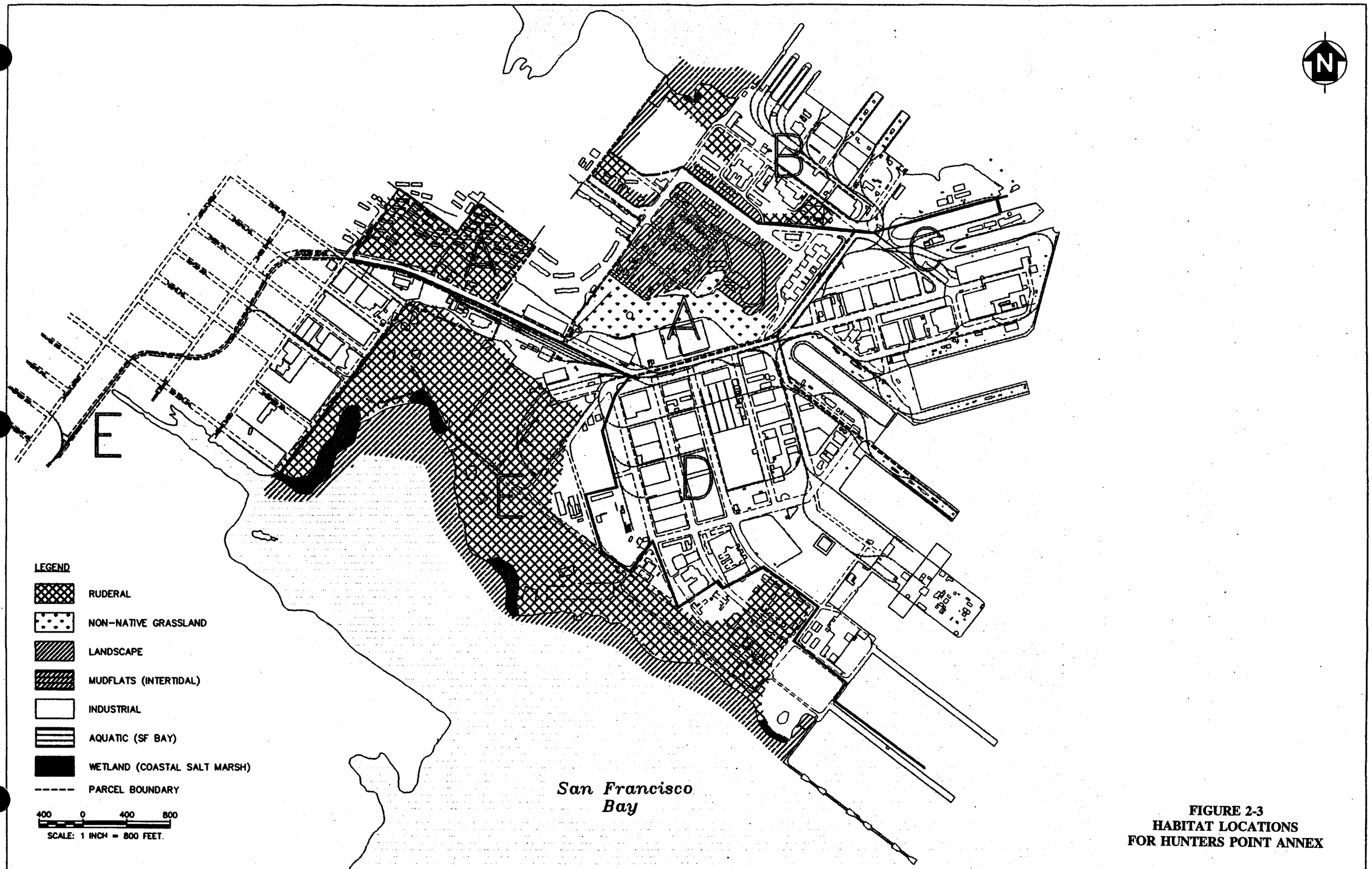


FIGURE 2-3
HABITAT LOCATIONS
FOR HUNTERS POINT ANNEX

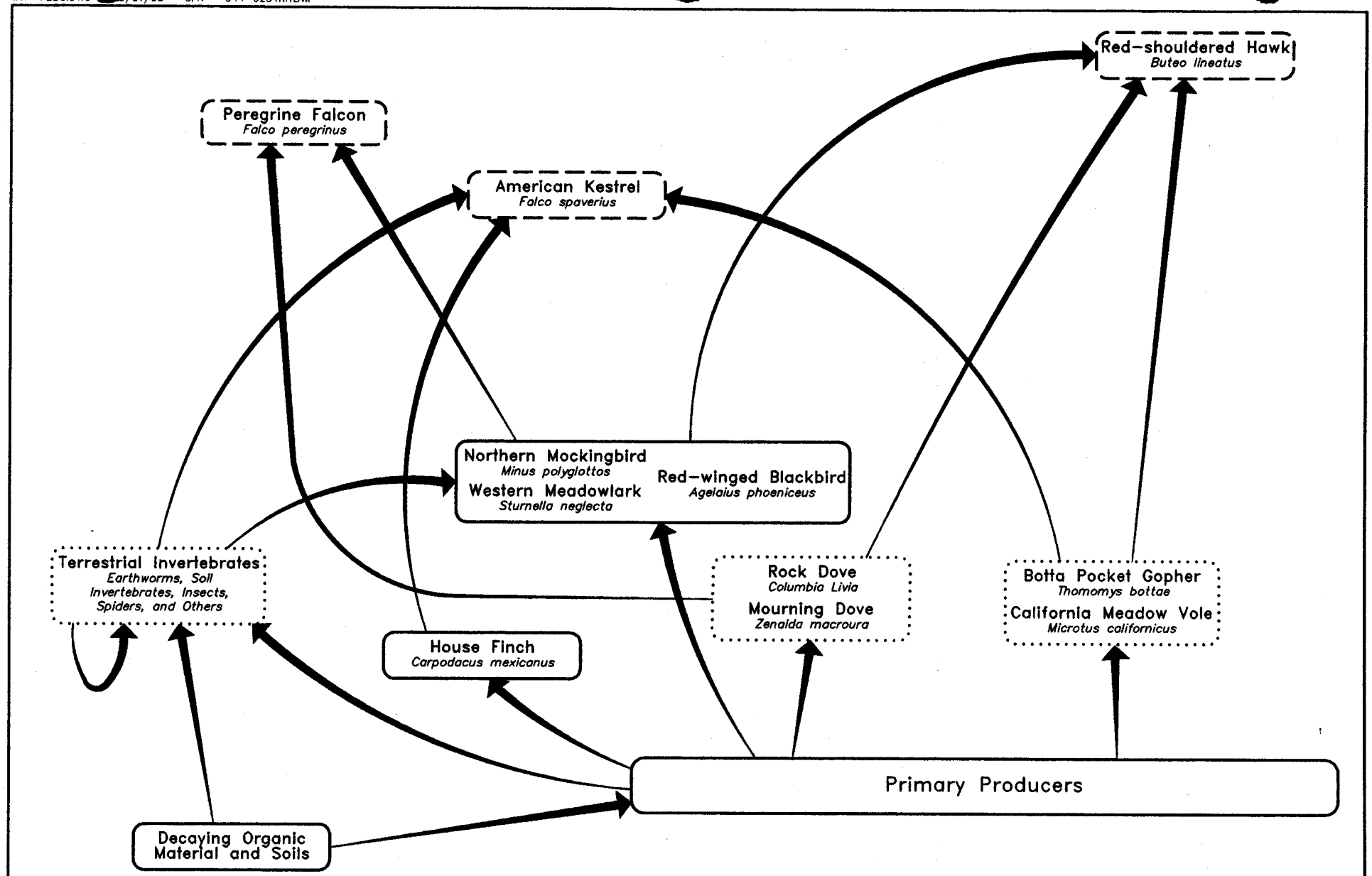
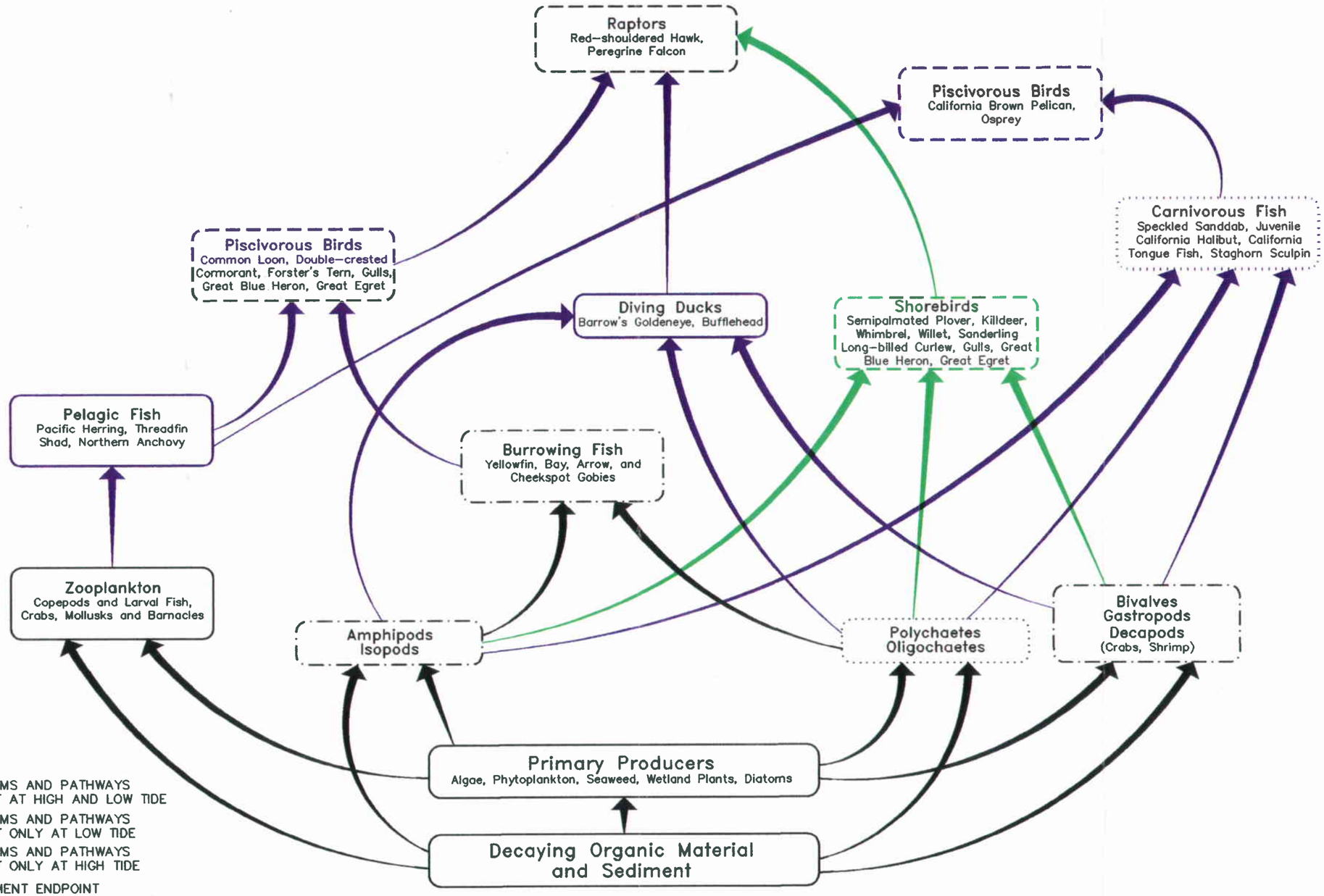


FIGURE 2-4
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
SIMPLIFIED TERRESTRIAL FOOD WEB EMPHASIZING
ASSESSMENT AND MEASUREMENT ENDPOINTS



NOTES: SCIENTIFIC NAMES FOR FOOD WEB ORGANISMS APPEAR IN THE TEXT.

PREDOMINANT FOOD WEB INTERACTIONS ARE REPRESENTED.

FIGURE 2-5
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
SIMPLIFIED INTERTIDAL FOOD WEB EMPHASIZING ASSESSMENT AND MEASUREMENT ENDPOINTS

SF-WEB3.DWG - 05/31/95 - CFR - 044-0254R1BWP

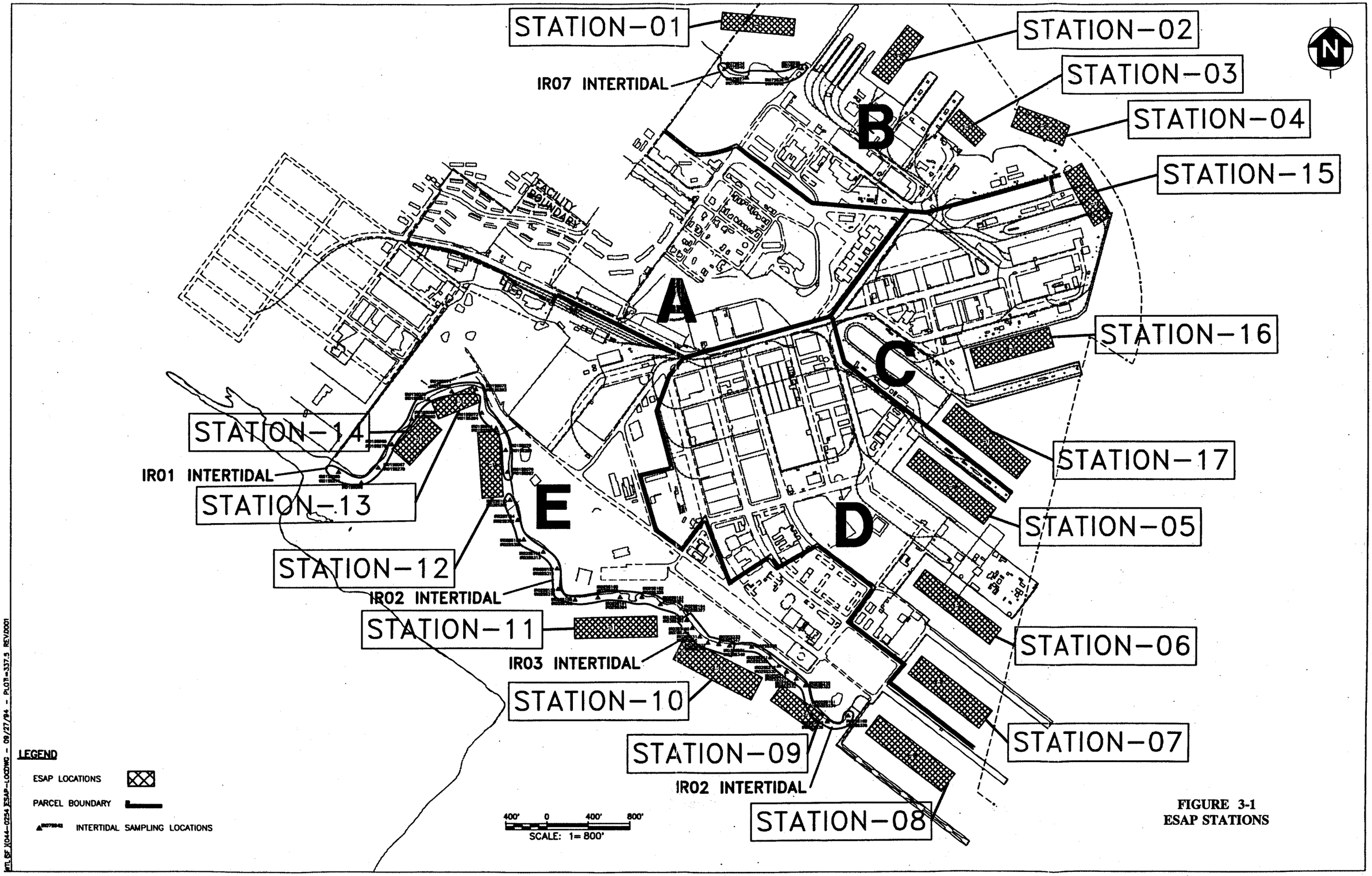


FIGURE 3-1
ESAP STATIONS

MTL SF)\044-0254 ESAP-LOCDWG - 09/27/94 - PLOT1=337.5 REV0001

STATION 01 – SURFACE SEDIMENT

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.3	ug/kg	2	20	1.15	0.12
4,4'-DDE	2.4	ug/kg	2.2	27	1.09	0.09
Arsenic	5.6	mg/kg	8.2	70	0.68	0.08
Chromium	74	mg/kg	81	370	0.91	0.20
Copper	45.9	mg/kg	34	270	1.35	0.17
Dieldrin	6.2	ug/kg	0.02	8	310.00	0.78
Endrin	2.2	ug/kg	0.02	45	110.00	0.05
Fluoranthene	510	ug/kg	600	5100	0.85	0.10
Lead	23.6	mg/kg	46.7	218	0.51	0.11
Mercury	0.26	mg/kg	0.15	0.71	1.73	0.37
Nickel	72.8	mg/kg	20.9	51.6	3.48	1.41
Pyrene	600	ug/kg	665	2600	0.90	0.23
Zinc	107	mg/kg	150	410	0.71	0.26
HAZARD INDEX					433.37	3.97

STATION 01 – SUBSURFACE SEDIMENT

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	5.5	ug/kg	2	20	2.75	0.28
4,4'-DDE	6	ug/kg	2.2	27	2.73	0.22
Arsenic	4.6	mg/kg	8.2	70	0.56	0.07
Chromium	93.5	mg/kg	81	370	1.15	0.25
Copper	58.2	mg/kg	34	270	1.71	0.22
Dieldrin	12	ug/kg	0.02	8	600.00	1.50
Endrin	4.8	ug/kg	0.02	45	240.00	0.11
Lead	27.2	mg/kg	46.7	218	0.58	0.12
Mercury	0.29	mg/kg	0.15	0.71	1.93	0.41
Nickel	96.5	mg/kg	20.9	51.6	4.62	1.87
Pyrene	680	ug/kg	665	2600	1.02	0.26
Zinc	140	mg/kg	150	410	0.93	0.34
HAZARD INDEX					857.99	5.64

STATION 02 – SURFACE SEDIMENT

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	4.2	ug/kg	2	20	2.10	0.21
4,4'-DDE	3.7	ug/kg	2.2	27	1.68	0.14
4,4'-DDT	9	ug/kg	1.58	46.1	5.70	0.20
Arsenic	3.6	mg/kg	8.2	70	0.44	0.05
Chromium	77.3	mg/kg	81	370	0.95	0.21
Copper	44.6	mg/kg	34	270	1.31	0.17
Dieldrin	7	ug/kg	0.02	8	350.00	0.88
Fluoranthene	440	ug/kg	600	5100	0.73	0.09
Lead	20.6	mg/kg	46.7	218	0.44	0.09
Mercury	0.32	mg/kg	0.15	0.71	2.13	0.45
Nickel	77.9	mg/kg	20.9	51.6	3.73	1.51
Pyrene	570	ug/kg	665	2600	0.86	0.22
Zinc	117	mg/kg	150	410	0.78	0.29
HAZARD INDEX					370.85	4.49

STATION 02 – SUBSURFACE SEDIMENT (2.5 feet)

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.5	ug/kg	2	20	1.25	0.13
4,4'-DDE	3.5	ug/kg	2.2	27	1.59	0.13
Arsenic	4.4	mg/kg	8.2	70	0.54	0.06
Chromium	85.9	mg/kg	81	370	1.06	0.23
Copper	52.1	mg/kg	34	270	1.53	0.19
Endrin	3	ug/kg	0.02	45	150.00	0.07
Lead	24.2	mg/kg	46.7	218	0.52	0.11
Mercury	0.28	mg/kg	0.15	0.71	1.87	0.39
Nickel	88.3	mg/kg	20.9	51.6	4.22	1.71
Zinc	122	mg/kg	150	410	0.81	0.30
HAZARD INDEX					163.39	3.32

STATION 03 – SURFACE SEDIMENT

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	2.6	ug/kg	2.2	27	1.18	0.10
Arsenic	7.2	mg/kg	8.2	70	0.88	0.10
Chromium	71.7	mg/kg	81	370	0.89	0.19
Copper	42.1	mg/kg	34	270	1.24	0.16
Endrin	1.8	ug/kg	0.02	45	90.00	0.04
Lead	23.1	mg/kg	46.7	218	0.49	0.11
Mercury	0.26	mg/kg	0.15	0.71	1.73	0.37
Nickel	73.2	mg/kg	20.9	51.6	3.50	1.42
Zinc	103	mg/kg	150	410	0.69	0.25
HAZARD INDEX					100.60	2.73

STATION 03 – SUBSURFACE SEDIMENT (2.5 feet)

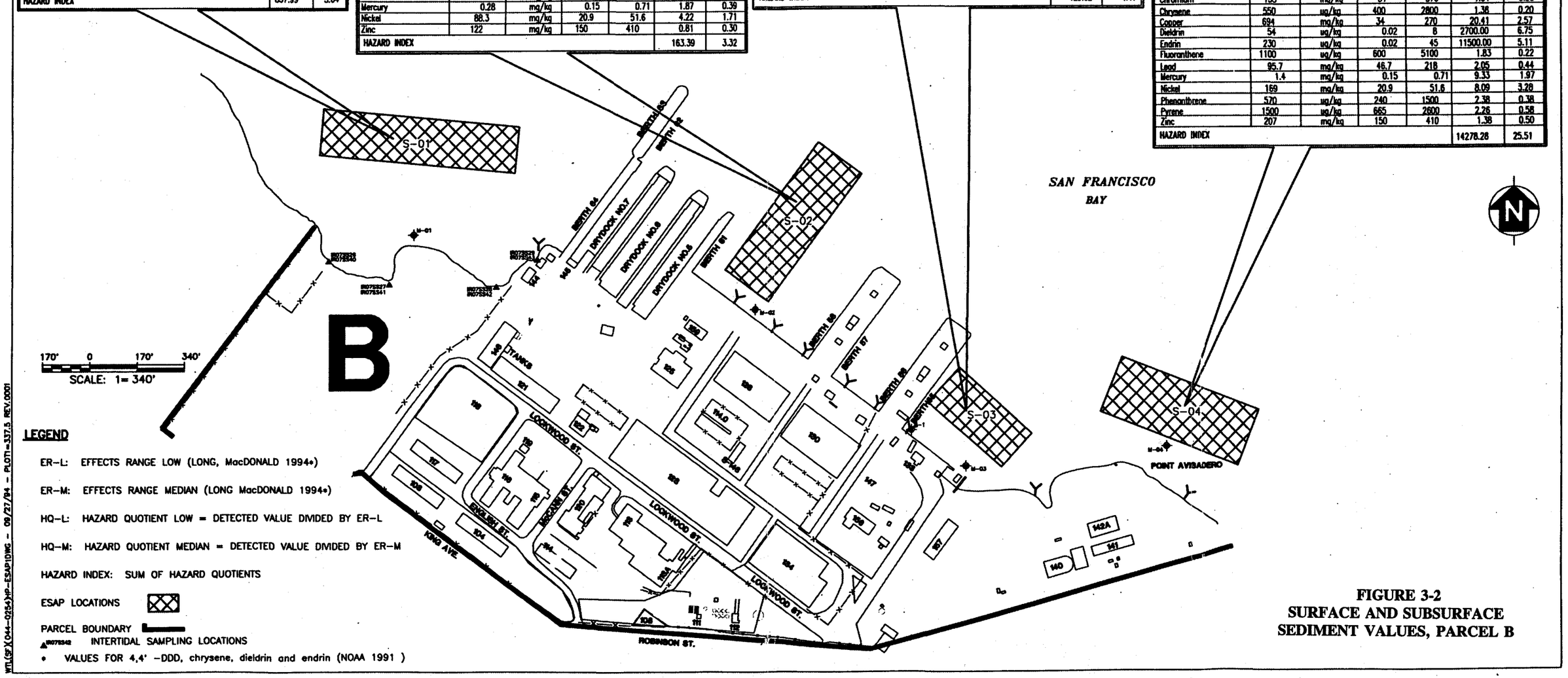
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	19	ug/kg	2	20	9.50	0.95
4,4'-DDE	4.9	ug/kg	2.2	27	2.23	0.18
Arsenic	3.3	mg/kg	8.2	70	0.40	0.05
Chromium	83.9	mg/kg	81	370	1.04	0.23
Copper	53.7	mg/kg	34	270	1.58	0.20
Endrin	8	ug/kg	0.02	45	400.00	0.18
Lead	23.2	mg/kg	46.7	218	0.50	0.11
Mercury	0.3	mg/kg	0.15	0.71	2.00	0.42
Nickel	79.5	mg/kg	20.9	51.6	3.80	1.54
Pyrene	610	ug/kg	665	2600	0.92	0.23
Zinc	159	mg/kg	150	410	1.06	0.39
HAZARD INDEX					423.02	4.47

STATION 04 – SURFACE SEDIMENT

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	32	ug/kg	2	20	16.00	1.60
Arsenic	65.4	mg/kg	8.2	70	7.98	0.93
Benzo(a)anthracene	340	ug/kg	261	1600	1.30	0.21
Benzo(a)pyrene	340	ug/kg	430	1600	0.79	0.21
Chromium	133	mg/kg	400	2800	0.33	0.05
Chrysene	460	ug/kg	400	2800	1.13	0.16
Copper	20.8	mg/kg	34	270	0.61	0.08
Dieldrin	56	ug/kg	0.02	8	2800.00	7.00
Endrin	100	ug/kg	0.02	45	5000.00	2.22
Fluoranthene	920	ug/kg	600	5100	1.53	0.18
Lead	157	mg/kg	46.7	218	3.36	0.72
Mercury	5.6	mg/kg	0.15	0.71	37.33	7.89
Nickel	113	mg/kg	20.9	51.6	5.41	2.19
Phenanthrene	650	ug/kg	240	1500	2.71	0.43
Pyrene	1200	ug/kg	665	2600	1.80	0.46
Zinc	267	mg/kg	150	410	1.78	0.65
HAZARD INDEX					7882.09	24.99

STATION 04 – SUBSURFACE SEDIMENT (2.5 feet)

CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	47	ug/mg	2	20	23.50	2.35
Arsenic	5.7	mg/kg	8.2	70	0.70	0.08
Benzo(a)anthracene	430	ug/kg	261	1600	1.65	0.27
Benzo(a)pyrene	730	ug/kg	430	1600	1.70	0.46
Chromium	133	mg/kg	81	370	1.64	0.36
Chrysene	550	ug/kg	400	2800	1.38	0.20
Copper	694	mg/kg	34	270	20.41	2.57
Dieldrin	54	ug/kg	0.02	8	2700.00	6.75
Endrin	230	ug/kg	0.02	45	11500.00	5.11
Fluoranthene	1100	ug/kg	600	5100	1.83	0.22
Lead	95.7	mg/kg	46.7	218	2.05	0.44
Mercury	1.4	mg/kg	0.15	0.71	9.33	1.97
Nickel	169	mg/kg	20.9	51.6	8.09	3.28
Phenanthrene	570	ug/kg	240	1500	2.38	0.38
Pyrene	1500	ug/kg	665	2600	2.26	0.58
Zinc	207	mg/kg	150	410	1.38	0.50
HAZARD INDEX					14278.28	25.51



LEGEND

ER-L: EFFECTS RANGE LOW (LONG, MacDONALD 1994+)

ER-M: EFFECTS RANGE MEDIAN (LONG MacDONALD 1994+)

HQ-L: HAZARD QUOTIENT LOW = DETECTED VALUE DIVIDED BY ER-L

HQ-M: HAZARD QUOTIENT MEDIAN = DETECTED VALUE DIVIDED BY ER-M

HAZARD INDEX: SUM OF HAZARD QUOTIENTS

ESAP LOCATIONS

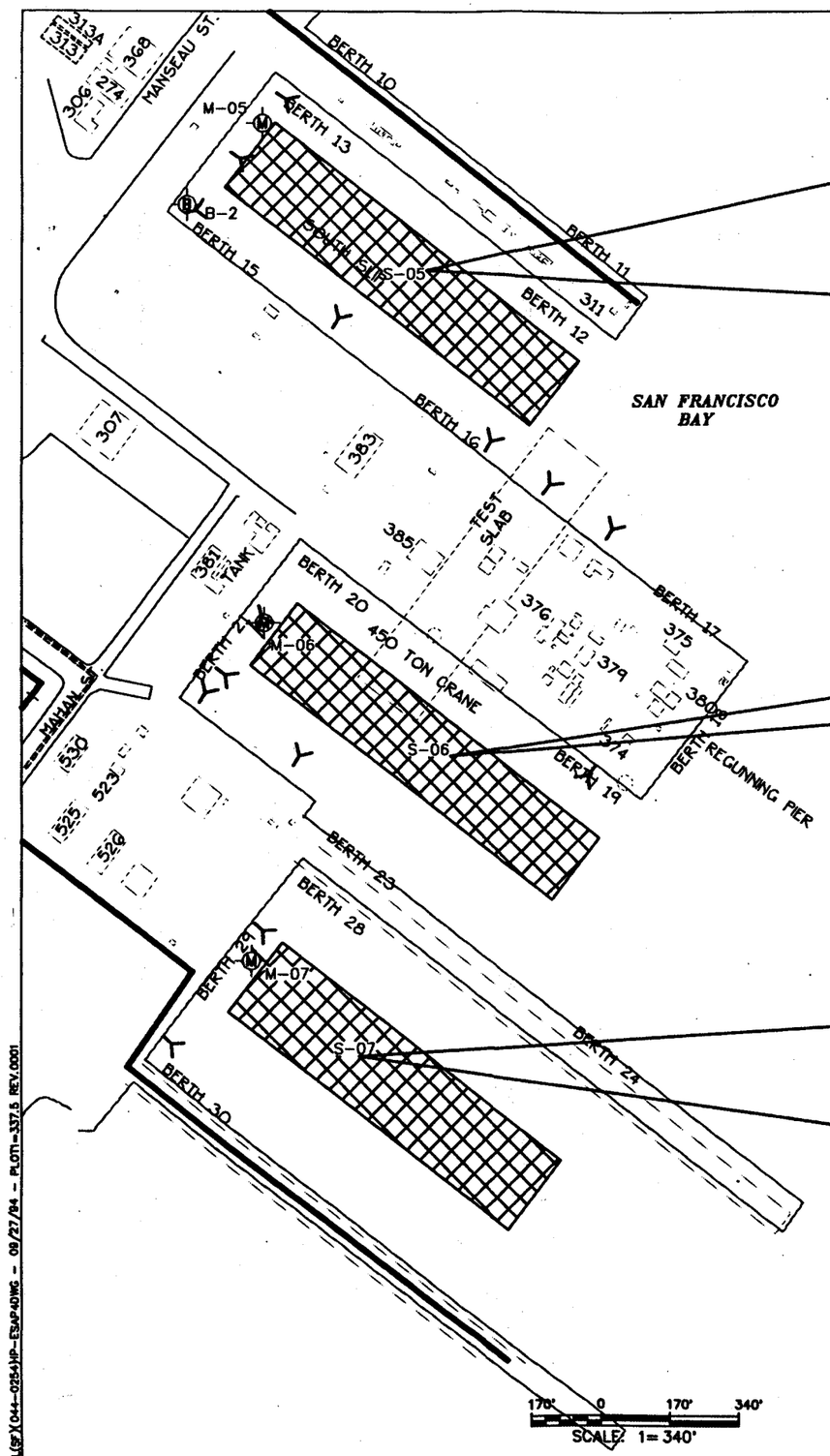
PARCEL BOUNDARY

INTERTIDAL SAMPLING LOCATIONS

* VALUES FOR 4,4' –DDD, chrysene, dieldrin and endrin (NOAA 1991)

FIGURE 3-2
SURFACE AND SUBSURFACE SEDIMENT VALUES, PARCEL B

WTL(SF)(044-0254)HP-ESAP1DWG - 09/27/94 - PLOT=337.5 REV.0001



STATION 05 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	5.3	ug/kg	2.2	27	2.41	0.20
Arsenic	3.7	mg/kg	8.2	70	0.45	0.05
Chromium	85	mg/kg	81	370	1.05	0.23
Copper	46.2	mg/kg	34	270	1.36	0.17
Endrin	4.4	ug/kg	0.02	45	220.00	0.10
Lead	22.8	mg/kg	46.7	218	0.49	0.10
Mercury	0.34	mg/kg	0.15	0.71	2.27	0.48
Nickel	83.2	mg/kg	20.9	51.6	3.98	1.61
Zinc	134	mg/kg	150	410	0.89	0.33
HAZARD INDEX					232.90	3.27

STATION 05 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	7.7	ug/kg	2	20	3.85	0.39
4,4'-DDE	8	ug/kg	2.2	27	3.64	0.30
Arsenic	2.5	mg/kg	8.2	70	0.30	0.04
Chromium	88.7	mg/kg	81	370	1.10	0.24
Copper	52.4	mg/kg	34	270	1.54	0.19
Endrin	5.4	ug/kg	0.02	45	270.00	0.12
Lead	24.9	mg/kg	46.7	218	0.53	0.11
Mercury	0.36	mg/kg	0.15	0.71	2.40	0.51
Nickel	81.4	mg/kg	20.9	51.6	3.89	1.58
Zinc	172	mg/kg	150	410	1.15	0.42
HAZARD INDEX					288.40	3.89

STATION 06 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.8	ug/kg	2	20	1.40	0.14
4,4'-DDE	2.6	ug/kg	2.2	27	1.18	0.10
4,4'-DDT	13	ug/kg	1.58	46.1	8.23	0.28
Arsenic	5.6	mg/kg	8.2	70	0.68	0.08
Benzo(a)pyrene	440	ug/kg	430	1600	1.02	0.28
Chromium	71.3	mg/kg	81	370	0.88	0.19
Chrysene	450	ug/kg	400	2800	1.13	0.16
Copper	43.7	mg/kg	34	270	1.29	0.16
Fluoranthene	780	ug/kg	600	5100	1.30	0.15
Lead	23.6	mg/kg	46.7	218	0.51	0.11
Mercury	1.1	mg/kg	0.15	0.71	7.33	1.55
Nickel	72.8	mg/kg	20.9	51.6	3.48	1.41
Pyrene	980	ug/kg	665	2600	1.47	0.38
Zinc	106	mg/kg	150	410	0.71	0.26
HAZARD INDEX					30.61	5.25

STATION 06 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	7.7	ug/kg	2	20	3.85	0.39
4,4'-DDE	8	ug/kg	2.2	27	3.64	0.30
Arsenic	2.5	mg/kg	8.2	70	0.30	0.04
Chromium	88.7	mg/kg	81	370	1.10	0.24
Copper	52.4	mg/kg	34	270	1.54	0.19
Endrin	5.4	ug/kg	0.02	45	270.00	0.12
Lead	24.9	mg/kg	46.7	218	0.53	0.11
Mercury	0.36	mg/kg	0.15	0.71	2.40	0.51
Nickel	81.4	mg/kg	20.9	51.6	3.89	1.58
Zinc	172	mg/kg	150	410	1.15	0.42
HAZARD INDEX					288.40	3.89

STATION 07 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.4	ug/kg	2	20	1.20	0.12
4,4'-DDE	2.1	ug/kg	2.2	27	0.95	0.08
Arsenic	3.6	mg/kg	8.2	70	0.44	0.05
Benzo(a)anthracene	370	ug/kg	261	1600	1.42	0.23
Benzo(a)pyrene	500	ug/kg	430	1600	1.16	0.31
Chromium	58	mg/kg	81	370	0.72	0.16
Chrysene	440	ug/kg	400	2800	1.10	0.16
Copper	32.7	mg/kg	34	270	0.96	0.12
Endrin	1.7	ug/kg	0.02	45	85.00	0.04
Fluoranthene	880	ug/kg	600	5100	1.47	0.17
Lead	87.9	mg/kg	46.7	218	1.88	0.40
Mercury	0.33	mg/kg	0.15	0.7	2.20	0.46
Nickel	64.5	mg/kg	20.9	51.6	3.09	1.25
Phenanthrene	600	ug/kg	240	1500	2.50	0.40
Pyrene	1200	ug/kg	665	2600	1.80	0.46
Zinc	110	mg/kg	150	410	0.73	0.27
HAZARD INDEX					106.62	4.69

STATION 07 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	5.6	ug/kg	2	20	2.80	0.28
4,4'-DDE	4.4	ug/kg	2.2	27	2.00	0.16
4,4'-DDT	7.6	ug/kg	1.58	46.1	4.81	0.16
Arsenic	2.9	mg/kg	8.2	70	0.35	0.04
Benzo(a)pyrene	400	ug/kg	430	1600	0.93	0.25
Chromium	73.3	mg/kg	81	370	0.90	0.20
Copper	44.5	mg/kg	34	270	1.31	0.16
Endrin	2.4	ug/kg	0.02	45	120.00	0.05
Fluoranthene	580	ug/kg	600	5100	0.97	0.11
Lead	140	mg/kg	46.7	218	3.00	0.64
Mercury	0.25	mg/kg	0.15	0.71	1.67	0.35
Nickel	70.4	mg/kg	20.9	51.6	3.37	1.36
Phenanthrene	380	ug/kg	240	1500	1.58	0.25
Pyrene	810	ug/kg	665	2600	1.22	0.31
Zinc	103	mg/kg	150	410	0.69	0.25
HAZARD INDEX					145.60	4.60

LEGEND

ER-L: EFFECTS RANGE LOW (LONG, MacDONALD 1994*)

ER-M: EFFECTS RANGE MEDIAN (LONG MacDONALD 1994*)

HQ-L: HAZARD QUOTIENT LOW = DETECTED VALUE DIVIDED BY ER-L

HQ-M: HAZARD QUOTIENT MEDIAN = DETECTED VALUE DIVIDED BY ER-M

HAZARD INDEX: SUM OF HAZARD QUOTIENTS

ESAP LOCATIONS

PARCEL BOUNDARY

* VALUES FOR 4,4' -DDD, chrysene, dieldrin and endrin (NOAA 1991)

FIGURE 3-3
SURFACE AND SUBSURFACE SEDIMENT VALUES, PARCEL D

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STATION 11 – SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	4.1	ug/kg	2	20	2.05	0.21
4,4'-DDE	5.1	ug/kg	2.2	27	2.32	0.19
4,4'-DDT	8.1	ug/kg	1.58	46.1	5.13	0.18
Arsenic	5	mg/kg	8.2	70	0.61	0.07
Chromium	98.9	mg/kg	81	370	1.22	0.27
Copper	64.1	mg/kg	34	270	1.89	0.24
Dieldrin	7.2	ug/kg	0.02	8	360.00	0.90
Endrin	8.5	ug/kg	0.02	45	425.00	0.19
Lead	35	mg/kg	46.7	218	0.75	0.16
Mercury	0.67	mg/kg	0.15	0.71	4.47	0.94
Nickel	101	mg/kg	20.9	51.6	4.83	1.96
Zinc	123	mg/kg	150	410	0.82	0.30
HAZARD INDEX					809.08	5.60

STATION 11 – SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
Arsenic	7.4	mg/kg	8.2	70	0.90	0.11
Chromium	84	mg/kg	81	370	1.04	0.23
Copper	40.6	mg/kg	34	270	1.19	0.15
Mercury	0.17	mg/kg	0.15	0.71	1.13	0.24
Nickel	87	mg/kg	20.9	51.6	4.16	1.69
Zinc	87.5	mg/kg	150	410	0.58	0.21
HAZARD INDEX					9.01	2.62

STATION 10 – SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	3.7	ug/kg	2	20	1.85	0.19
4,4'-DDE	3.5	ug/kg	2.2	27	1.59	0.13
4,4'-DDT	7.3	ug/kg	1.58	46.1	4.62	0.16
Arsenic	3.8	mg/kg	8.2	70	0.46	0.05
Benzo(a)pyrene	330	ug/kg	430	1600	0.77	0.21
Chromium	95.8	mg/kg	81	370	1.18	0.26
Copper	51.7	mg/kg	34	270	1.52	0.19
Dieldrin	6.9	ug/kg	0.02	8	345.00	0.86
Endrin	4.5	ug/kg	0.02	45	225.00	0.10
Fluoranthene	530	ug/kg	600	5100	0.88	0.10
Lead	28.4	mg/kg	46.7	218	0.61	0.13
Mercury	0.37	mg/kg	0.15	0.71	2.47	0.52
Nickel	82.8	mg/kg	20.9	51.6	3.96	1.60
Pyrene	710	ug/kg	665	2600	1.07	0.27
Zinc	119	mg/kg	150	410	0.79	0.29
HAZARD INDEX					591.78	5.07

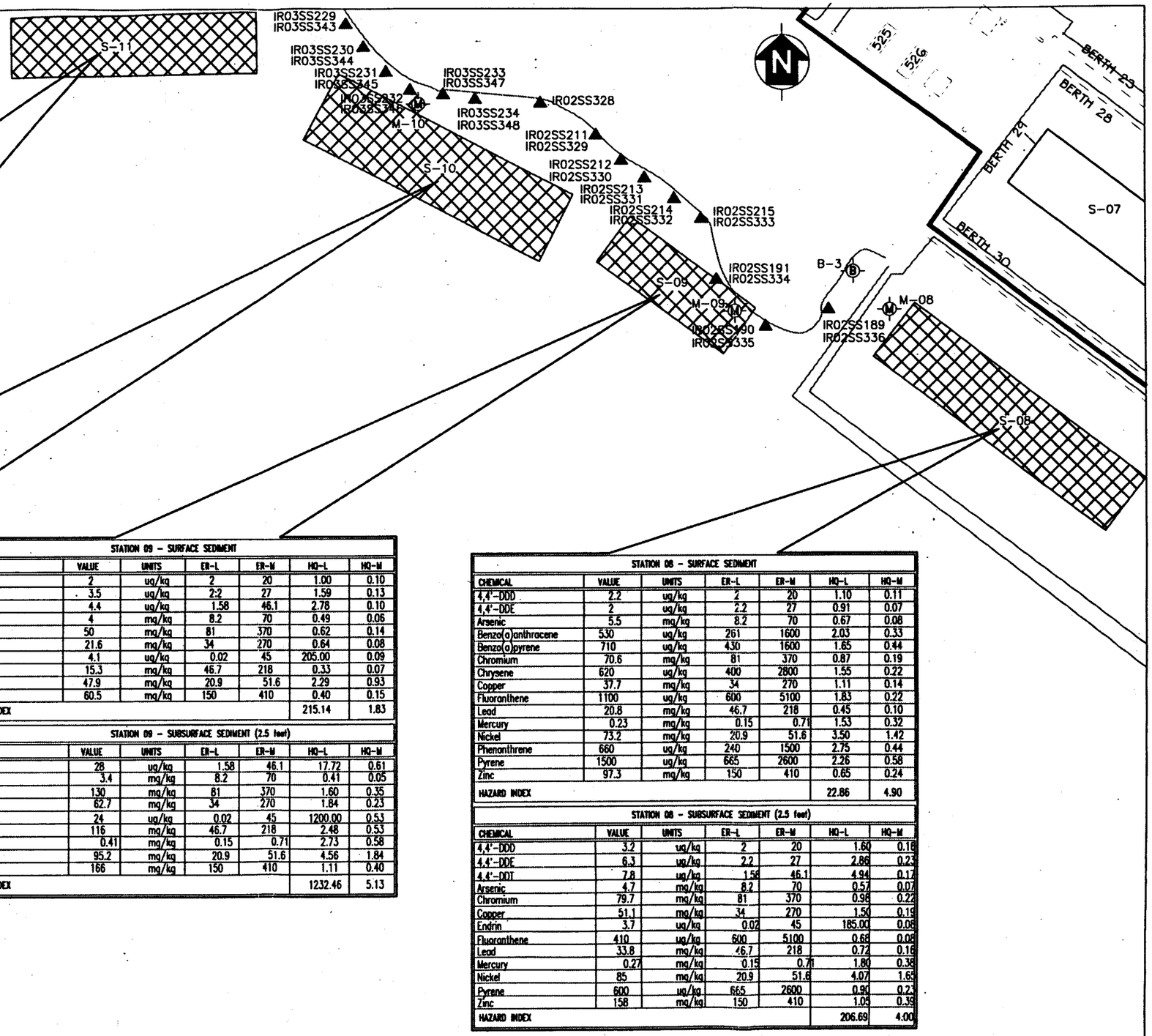
STATION 10 – SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	4.4	ug/kg	2.2	27	2.00	0.16
Chromium	75.9	mg/kg	81	370	0.94	0.21
Copper	37.7	mg/kg	34	270	1.11	0.14
Endrin	2.3	ug/kg	0.02	45	115.00	0.05
Lead	10.2	mg/kg	46.7	218	0.22	0.05
Mercury	0.32	mg/kg	0.15	0.71	2.13	0.45
Nickel	62.3	mg/kg	20.9	51.6	2.98	1.21
Zinc	74.5	mg/kg	150	410	0.50	0.18
HAZARD INDEX					124.88	2.45

STATION 09 – SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2	ug/kg	2	20	1.00	0.10
4,4'-DDE	3.5	ug/kg	2.2	27	1.59	0.13
4,4'-DDT	4.4	ug/kg	1.58	46.1	2.78	0.10
Arsenic	4	mg/kg	8.2	70	0.49	0.06
Chromium	50	mg/kg	81	370	0.62	0.14
Copper	21.6	mg/kg	34	270	0.64	0.08
Endrin	4.1	ug/kg	0.02	45	205.00	0.09
Lead	15.3	mg/kg	46.7	218	0.33	0.07
Nickel	47.9	mg/kg	20.9	51.6	2.29	0.93
Zinc	60.5	mg/kg	150	410	0.40	0.15
HAZARD INDEX					215.14	1.83

STATION 09 – SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDT	28	ug/kg	1.58	46.1	17.72	0.61
Arsenic	3.4	mg/kg	8.2	70	0.41	0.05
Chromium	130	mg/kg	81	370	1.60	0.35
Copper	62.7	mg/kg	34	270	1.84	0.23
Endrin	24	ug/kg	0.02	45	1200.00	0.53
Lead	116	mg/kg	46.7	218	2.48	0.53
Mercury	0.41	mg/kg	0.15	0.71	2.73	0.58
Nickel	95.2	mg/kg	20.9	51.6	4.56	1.84
Zinc	166	mg/kg	150	410	1.11	0.40
HAZARD INDEX					1232.46	5.13

STATION 08 – SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	2.2	ug/kg	2	20	1.10	0.11
4,4'-DDE	2	ug/kg	2.2	27	0.91	0.07
Arsenic	5.5	mg/kg	8.2	70	0.67	0.08
Benzo(a)anthracene	530	ug/kg	261	1600	2.03	0.33
Benzo(a)pyrene	710	ug/kg	430	1600	1.65	0.44
Chromium	70.6	mg/kg	81	370	0.87	0.19
Chrysene	620	ug/kg	400	2800	1.55	0.22
Copper	37.7	mg/kg	34	270	1.11	0.14
Fluoranthene	1100	ug/kg	600	5100	1.83	0.22
Lead	20.8	mg/kg	46.7	218	0.45	0.10
Mercury	0.23	mg/kg	0.15	0.71	1.53	0.32
Nickel	73.2	mg/kg	20.9	51.6	3.50	1.42
Phenanthrene	660	ug/kg	240	1500	2.75	0.44
Pyrene	1500	ug/kg	665	2600	2.26	0.58
Zinc	97.3	mg/kg	150	410	0.65	0.24
HAZARD INDEX					22.86	4.90

STATION 08 – SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	3.2	ug/kg	2	20	1.60	0.16
4,4'-DDE	6.3	ug/kg	2.2	27	2.86	0.23
4,4'-DDT	7.8	ug/kg	1.58	46.1	4.94	0.17
Arsenic	4.7	mg/kg	8.2	70	0.57	0.07
Chromium	79.7	mg/kg	81	370	0.98	0.22
Copper	51.1	mg/kg	34	270	1.50	0.19
Endrin	3.7	ug/kg	0.02	45	185.00	0.08
Fluoranthene	410	ug/kg	600	5100	0.68	0.08
Lead	33.8	mg/kg	46.7	218	0.72	0.16
Mercury	0.27	mg/kg	0.15	0.71	1.80	0.38
Nickel	85	mg/kg	20.9	51.6	4.07	1.65
Pyrene	600	ug/kg	665	2600	0.90	0.23
Zinc	158	mg/kg	150	410	1.05	0.39
HAZARD INDEX					206.69	4.00



LEGEND

ER-L: EFFECTS RANGE LOW (LONG, MacDONALD 1994•)

ER-M: EFFECTS RANGE MEDIAN (LONG MacDONALD 1994•)

HQ-L: HAZARD QUOTIENT LOW = DETECTED VALUE DIVIDED BY ER-L

HQ-M: HAZARD QUOTIENT MEDIAN = DETECTED VALUE DIVIDED BY ER-M

HAZARD INDEX: SUM OF HAZARD QUOTIENTS

ESAP LOCATIONS

PARCEL BOUNDARY

▲ IR02SS328 INTERTIDAL LOCATIONS

• VALUES FOR 4,4' -DDD, chrysene, dieldrin and endrin (NOAA 1991)

170' 0 170' 340'

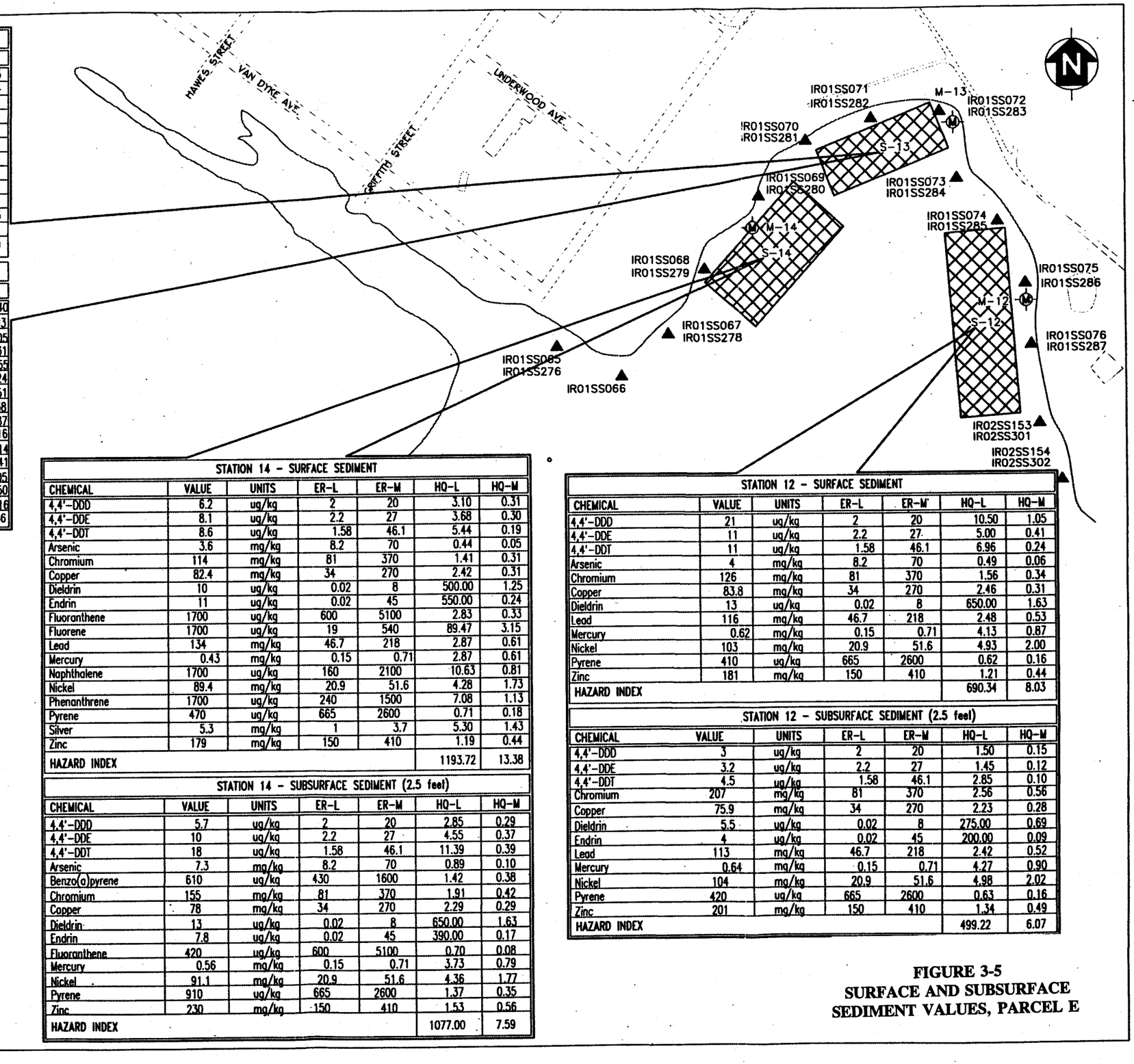
SCALE: 1= 340'

FIGURE 3-4
SURFACE AND SUBSURFACE SEDIMENT VALUES, PARCEL E

WTL(SF)(044-0254)HP-ESAP5DWG - 09/28/94 - PLOT1=337.5 REV.0002

STATION 13 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	31	ug/kg	2	20	15.50	1.55
4,4'-DDE	39	ug/kg	2.2	27	17.73	1.44
4,4'-DDT	41	ug/kg	1.58	46.1	25.95	0.89
Arsenic	3.9	mg/kg	8.2	70	0.48	0.06
Chromium	112	mg/kg	81	370	1.38	0.30
Copper	74.3	mg/kg	34	270	2.19	0.28
Dieldrin	76	ug/kg	0.02	8	3800.00	9.50
Endrin	40	ug/kg	0.02	45	2000.00	0.89
Lead	83	mg/kg	46.7	218	1.78	0.38
Mercury	0.63	mg/kg	0.15	0.71	4.20	0.89
Nickel	94.2	mg/kg	20.9	51.6	4.51	1.83
Zinc	166	mg/kg	150	410	1.11	0.40
HAZARD INDEX					5874.81	18.40

STATION 13 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	28	ug/kg	2	20	14.00	1.40
4,4'-DDE	160	ug/kg	2.2	27	72.73	5.93
Arsenic	3.5	mg/kg	8.2	70	0.43	0.05
Benzo(a)pyrene	500	ug/kg	430	1600	1.16	0.31
Chromium	575	mg/kg	81	370	7.10	1.55
Chrysene	680	ug/kg	400	2800	1.70	0.24
Copper	138	mg/kg	34	270	4.06	0.51
Dieldrin	67	ug/kg	0.02	8	3350.00	8.38
Endrin	39	ug/kg	0.02	45	1950.00	0.87
Fluoranthene	830	ug/kg	600	5100	1.38	0.16
Lead	248	mg/kg	46.7	218	5.31	1.14
Mercury	1	mg/kg	0.15	0.71	6.67	1.41
Nickel	106	mg/kg	20.9	51.6	5.07	2.05
Pyrene	1300	ug/kg	665	2600	1.95	0.50
Zinc	477	mg/kg	150	410	3.18	1.16
HAZARD INDEX					5424.74	25.66



STATION 14 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	6.2	ug/kg	2	20	3.10	0.31
4,4'-DDE	8.1	ug/kg	2.2	27	3.68	0.30
4,4'-DDT	8.6	ug/kg	1.58	46.1	5.44	0.19
Arsenic	3.6	mg/kg	8.2	70	0.44	0.05
Chromium	114	mg/kg	81	370	1.41	0.31
Copper	82.4	mg/kg	34	270	2.42	0.31
Dieldrin	10	ug/kg	0.02	8	500.00	1.25
Endrin	11	ug/kg	0.02	45	550.00	0.24
Fluoranthene	1700	ug/kg	600	5100	2.83	0.33
Fluorene	1700	ug/kg	19	540	89.47	3.15
Lead	134	mg/kg	46.7	218	2.87	0.61
Mercury	0.43	mg/kg	0.15	0.71	2.87	0.61
Naphthalene	1700	ug/kg	160	2100	10.63	0.81
Nickel	89.4	mg/kg	20.9	51.6	4.28	1.73
Phenanthrene	1700	ug/kg	240	1500	7.08	1.13
Pyrene	470	ug/kg	665	2600	0.71	0.18
Silver	5.3	mg/kg	1	3.7	5.30	1.43
Zinc	179	mg/kg	150	410	1.19	0.44
HAZARD INDEX					1193.72	13.38

STATION 14 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	5.7	ug/kg	2	20	2.85	0.29
4,4'-DDE	10	ug/kg	2.2	27	4.55	0.37
4,4'-DDT	18	ug/kg	1.58	46.1	11.39	0.39
Arsenic	7.3	mg/kg	8.2	70	0.89	0.10
Benzo(a)pyrene	610	ug/kg	430	1600	1.42	0.38
Chromium	155	mg/kg	81	370	1.91	0.42
Copper	78	mg/kg	34	270	2.29	0.29
Dieldrin	13	ug/kg	0.02	8	650.00	1.63
Endrin	7.8	ug/kg	0.02	45	390.00	0.17
Fluoranthene	420	ug/kg	600	5100	0.70	0.08
Mercury	0.56	mg/kg	0.15	0.71	3.73	0.79
Nickel	91.1	mg/kg	20.9	51.6	4.36	1.77
Pyrene	910	ug/kg	665	2600	1.37	0.35
Zinc	230	mg/kg	150	410	1.53	0.56
HAZARD INDEX					1077.00	7.59

STATION 12 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	21	ug/kg	2	20	10.50	1.05
4,4'-DDE	11	ug/kg	2.2	27	5.00	0.41
4,4'-DDT	11	ug/kg	1.58	46.1	6.96	0.24
Arsenic	4	mg/kg	8.2	70	0.49	0.06
Chromium	126	mg/kg	81	370	1.56	0.34
Copper	83.8	mg/kg	34	270	2.46	0.31
Dieldrin	13	ug/kg	0.02	8	650.00	1.63
Lead	116	mg/kg	46.7	218	2.48	0.53
Mercury	0.62	mg/kg	0.15	0.71	4.13	0.87
Nickel	103	mg/kg	20.9	51.6	4.93	2.00
Pyrene	410	ug/kg	665	2600	0.62	0.16
Zinc	181	mg/kg	150	410	1.21	0.44
HAZARD INDEX					690.34	8.03

STATION 12 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	3	ug/kg	2	20	1.50	0.15
4,4'-DDE	3.2	ug/kg	2.2	27	1.45	0.12
4,4'-DDT	4.5	ug/kg	1.58	46.1	2.85	0.10
Chromium	207	mg/kg	81	370	2.56	0.56
Copper	75.9	mg/kg	34	270	2.23	0.28
Dieldrin	5.5	ug/kg	0.02	8	275.00	0.69
Endrin	4	ug/kg	0.02	45	200.00	0.09
Lead	113	mg/kg	46.7	218	2.42	0.52
Mercury	0.64	mg/kg	0.15	0.71	4.27	0.90
Nickel	104	mg/kg	20.9	51.6	4.98	2.02
Pyrene	420	ug/kg	665	2600	0.63	0.16
Zinc	201	mg/kg	150	410	1.34	0.49
HAZARD INDEX					499.22	6.07

170' 0 170' 340'

SCALE: 1= 340'

LEGEND

ER-L: EFFECTS RANGE LOW (LONG, MacDONALD 1994•)

ER-M: EFFECTS RANGE MEDIAN (LONG MacDONALD 1994•)

HQ-L: HAZARD QUOTIENT LOW = DETECTED VALUE DIVIDED BY ER-L

HQ-M: HAZARD QUOTIENT MEDIAN = DETECTED VALUE DIVIDED BY ER-M

HAZARD INDEX: SUM OF HAZARD QUOTIENTS

ESAP LOCATIONS

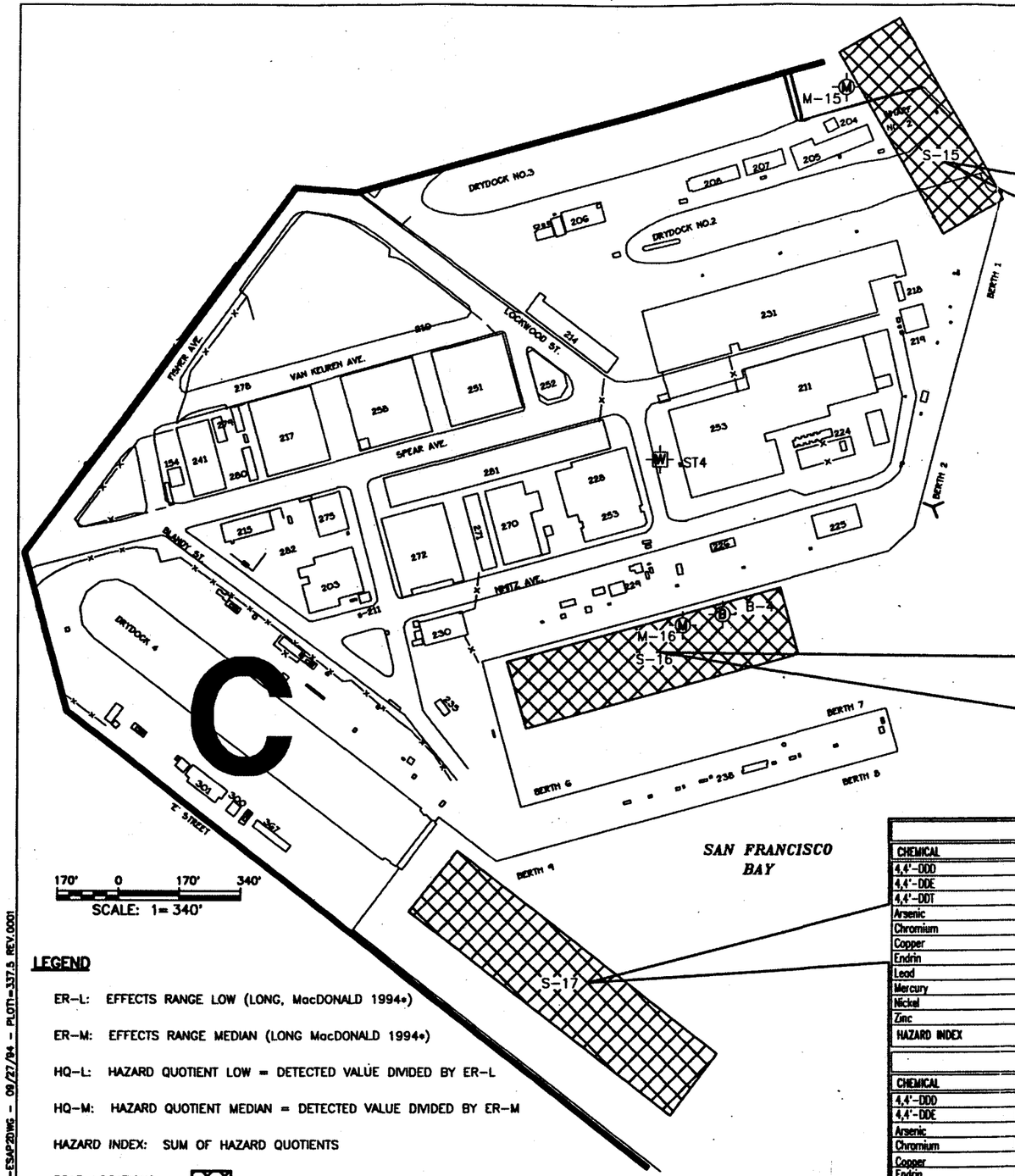
PARCEL BOUNDARY

▲ IR02SS338 INTERTIDAL LOCATION

• VALUES FOR 4,4' -DDD, chrysene, dieldrin and endrin (NOAA 1991)

W:\(SFX)044-0254\RP-ESAP3D.WG - 09/28/94 - PLOT=337.5 REV.0002

FIGURE 3-5
SURFACE AND SUBSURFACE SEDIMENT VALUES, PARCEL E



STATION 15 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	2.7	ug/kg	2.2	27	1.23	0.10
Arsenic	6.1	mg/kg	8.2	70	0.74	0.09
Chromium	78.5	mg/kg	81	370	0.97	0.21
Copper	49.4	mg/kg	34	270	1.45	0.18
Endrin	3	ug/kg	0.02	45	150.00	0.07
Lead	271	mg/kg	46.7	218	5.80	1.24
Mercury	0.35	mg/kg	0.15	0.71	2.33	0.49
Nickel	81.8	mg/kg	20.9	51.6	3.91	1.59
Pyrene	700	ug/kg	665	2600	1.05	0.27
Zinc	115	mg/kg	150	410	0.77	0.28
HAZARD INDEX					168.26	4.52

STATION 14 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	22	ug/kg	2.2	27	10.00	0.81
4,4'-DDT	34	ug/kg	1.58	46.1	21.52	0.74
Arsenic	4.5	mg/kg	8.2	70	0.55	0.06
Chromium	95.8	mg/kg	81	370	1.18	0.26
Copper	63.7	mg/kg	34	270	1.87	0.24
Dieldrin	5.3	ug/kg	0.02	8	265.00	0.66
Endrin	6.3	ug/kg	0.02	45	315.00	0.14
Fluoranthene	510	ug/kg	600	5100	0.85	0.10
Lead	39.4	mg/kg	46.7	218	0.84	0.18
Mercury	3.4	mg/kg	0.15	0.71	22.67	4.79
Nickel	93.8	mg/kg	20.9	51.6	4.49	1.82
Pyrene	880	ug/kg	665	2600	1.32	0.34
Zinc	147	mg/kg	150	410	0.98	0.36
HAZARD INDEX					646.28	10.50

STATION 16 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	3.1	ug/kg	2.2	27	1.41	0.11
Arsenic	5.1	mg/kg	8.2	70	0.62	0.07
Chromium	80.7	mg/kg	81	370	1.00	0.22
Copper	51.2	mg/kg	34	270	1.51	0.19
Endrin	2	ug/kg	0.02	45	100.00	0.04
Lead	172	mg/kg	46.7	218	3.68	0.79
Mercury	0.28	mg/kg	0.15	0.71	1.87	0.39
Nickel	84.2	mg/kg	20.9	51.6	4.03	1.63
Pyrene	500	ug/kg	665	2600	0.75	0.19
Zinc	141	mg/kg	150	410	0.94	0.34
HAZARD INDEX					115.80	3.99

STATION 16 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDE	6.3	ug/kg	2.2	27	2.86	0.23
4,4'-DDT	11	ug/kg	1.58	46.1	6.96	0.24
Arsenic	4.8	mg/kg	8.2	70	0.59	0.07
Chromium	101	mg/kg	81	370	1.25	0.27
Copper	65.2	mg/kg	34	270	1.92	0.24
Dieldrin	5	ug/kg	0.02	8	250.00	0.63
Endrin	8.9	ug/kg	0.02	45	445.00	0.20
Lead	375	mg/kg	46.7	218	8.03	1.72
Mercury	0.76	mg/kg	0.15	0.71	5.07	1.07
Nickel	102	mg/kg	20.9	51.6	4.88	1.98
Pyrene	500	ug/kg	665	2600	0.75	0.19
Zinc	153	mg/kg	150	410	1.02	0.37
HAZARD INDEX					728.32	7.21

STATION 17 - SURFACE SEDIMENT						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	3.2	ug/kg	2	20	1.60	0.16
4,4'-DDE	3.3	ug/kg	2.2	27	1.50	0.12
4,4'-DDT	7.9	ug/kg	1.58	46.1	5.00	0.17
Arsenic	5.6	mg/kg	8.2	70	0.68	0.08
Chromium	79.6	mg/kg	81	370	0.98	0.22
Copper	46	mg/kg	34	270	1.35	0.17
Endrin	1.8	ug/kg	0.02	45	90.00	0.04
Lead	22.8	mg/kg	46.7	218	0.49	0.10
Mercury	0.36	mg/kg	0.15	0.71	2.40	0.51
Nickel	83.7	mg/kg	20.9	51.6	4.00	1.62
Zinc	118	mg/kg	150	410	0.79	0.29
HAZARD INDEX					108.80	3.48

STATION 17 - SUBSURFACE SEDIMENT (2.5 feet)						
CHEMICAL	VALUE	UNITS	ER-L	ER-M	HQ-L	HQ-M
4,4'-DDD	5.2	ug/kg	2	20	2.60	0.26
4,4'-DDE	11	ug/kg	2.2	27	5.00	0.41
Arsenic	4.2	mg/kg	8.2	70	0.51	0.06
Chromium	83.4	mg/kg	81	370	1.03	0.23
Copper	49.6	mg/kg	34	270	1.46	0.18
Endrin	3.9	ug/kg	0.02	45	195.00	0.09
Lead	278	mg/kg	46.7	218	5.95	1.28
Mercury	0.26	mg/kg	0.15	0.71	1.73	0.37
Nickel	82.5	mg/kg	20.9	51.6	3.95	1.60
Zinc	129	mg/kg	150	410	0.86	0.31
HAZARD INDEX					218.09	4.78

LEGEND

ER-L: EFFECTS RANGE LOW (LONG, MacDONALD 1994•)

ER-M: EFFECTS RANGE MEDIAN (LONG MacDONALD 1994•)

HQ-L: HAZARD QUOTIENT LOW = DETECTED VALUE DIVIDED BY ER-L

HQ-M: HAZARD QUOTIENT MEDIAN = DETECTED VALUE DIVIDED BY ER-M

HAZARD INDEX: SUM OF HAZARD QUOTIENTS

ESAP LOCATIONS

PARCEL BOUNDARY

• VALUES FOR 4,4' -DDD, chrysene, dieldrin and endrin (NOAA 1991)

FIGURE 3-6
SURFACE AND SUBSURFACE SEDIMENT VALUES, PARCEL C

M:\(SFX)044-0254\MP-ESAP2D.WG - 06/27/94 - PLOT1=337.5 REV.0001

FIGURE 3-7

SURFACE SEDIMENT
HAZARD INDEX BASED ON ER-L

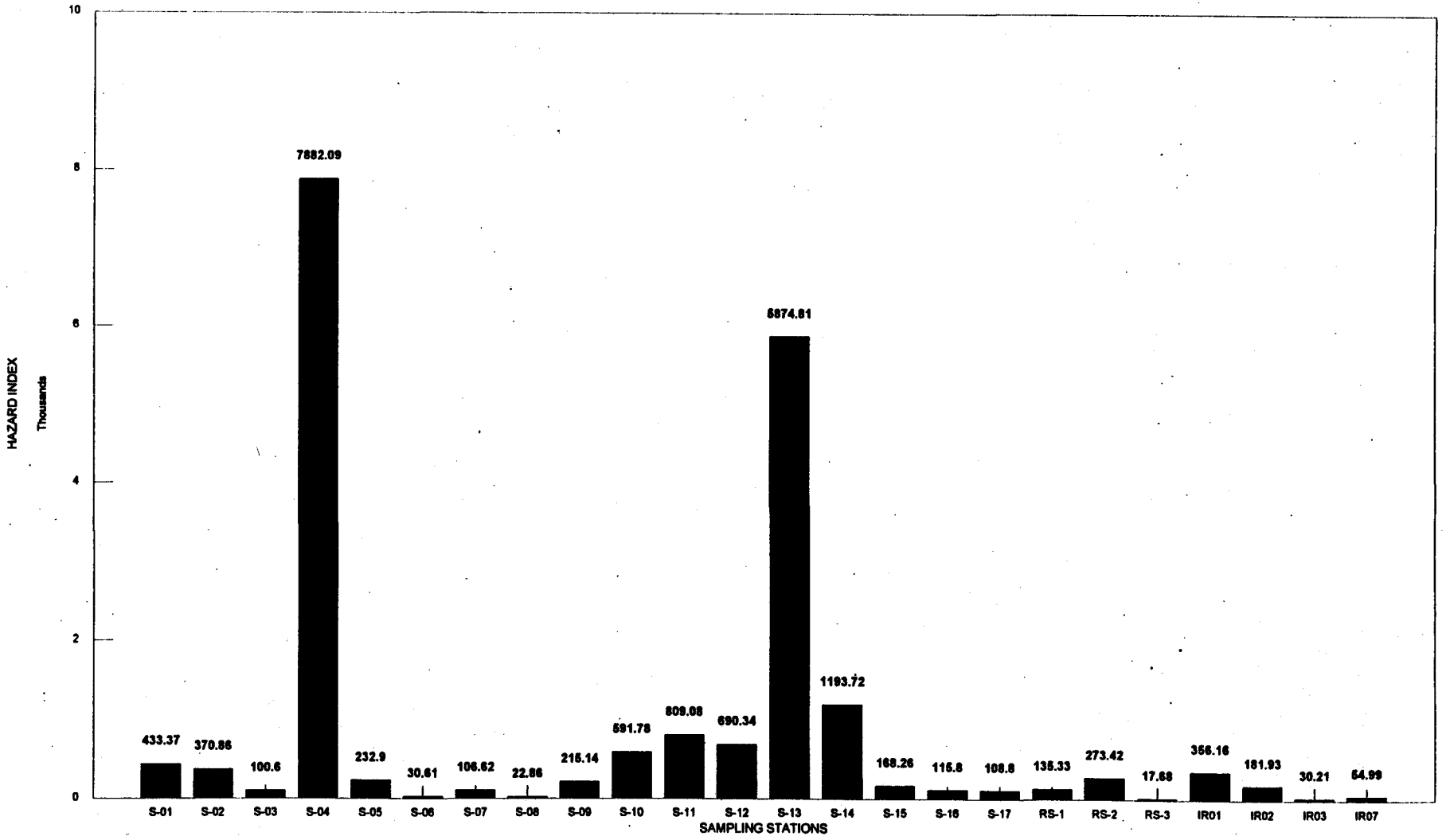


FIGURE 3-8

SUBSURFACE SEDIMENT (2.5)
HAZARD INDEX BASED ON ER-L

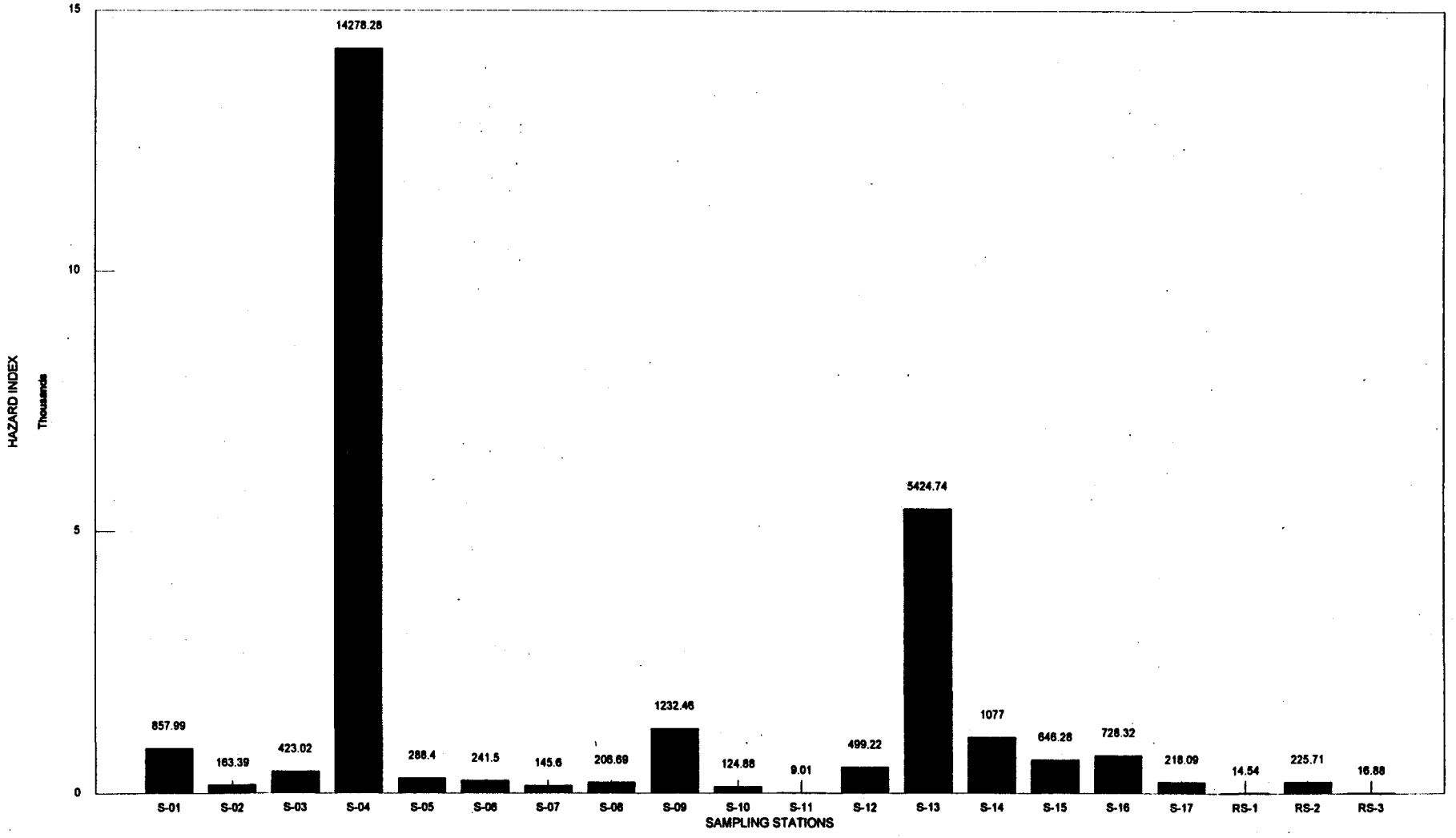


FIGURE 3-9

SURFACE SEDIMENT
HAZARD INDEX BASED ON ER-M

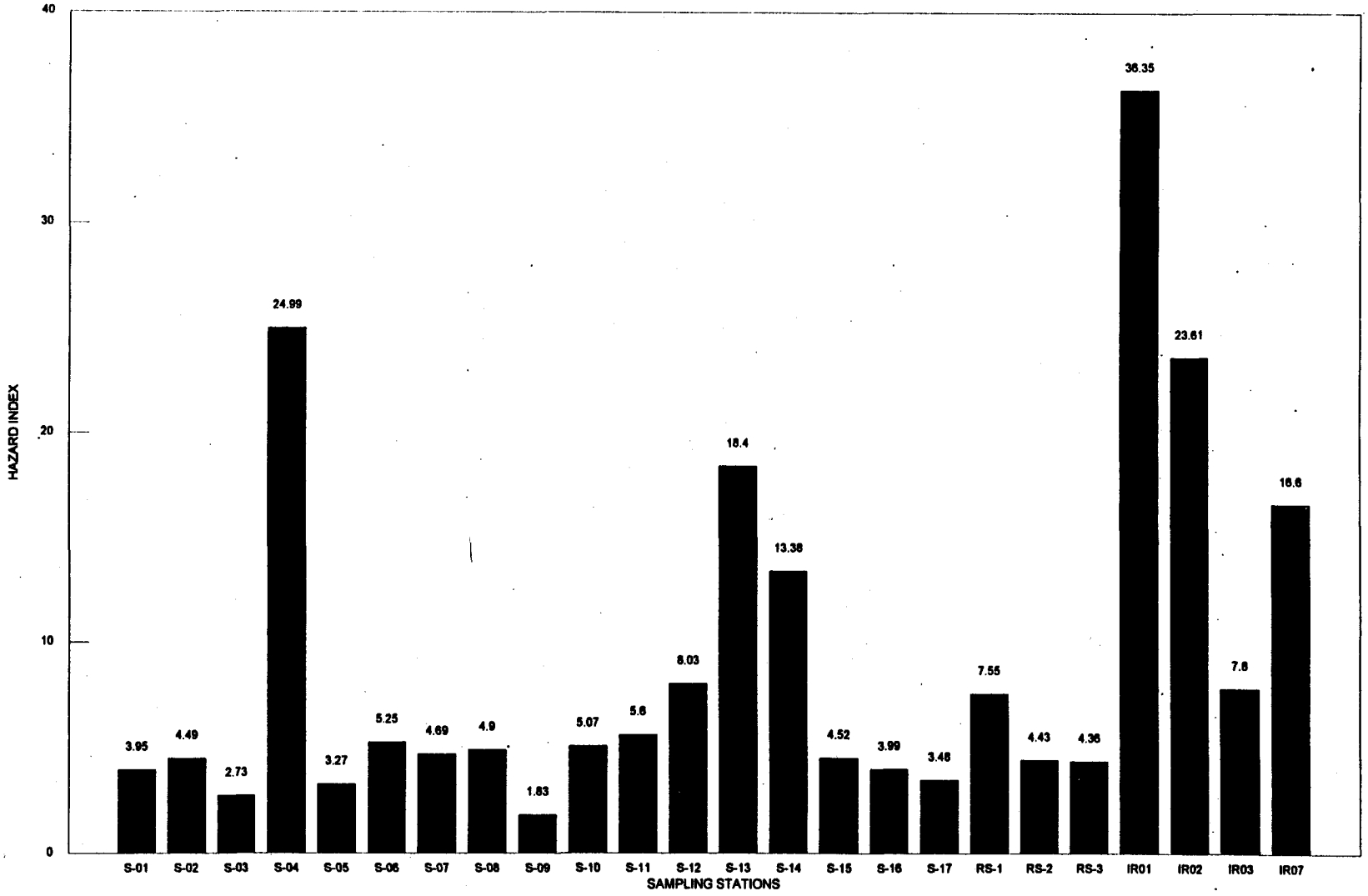
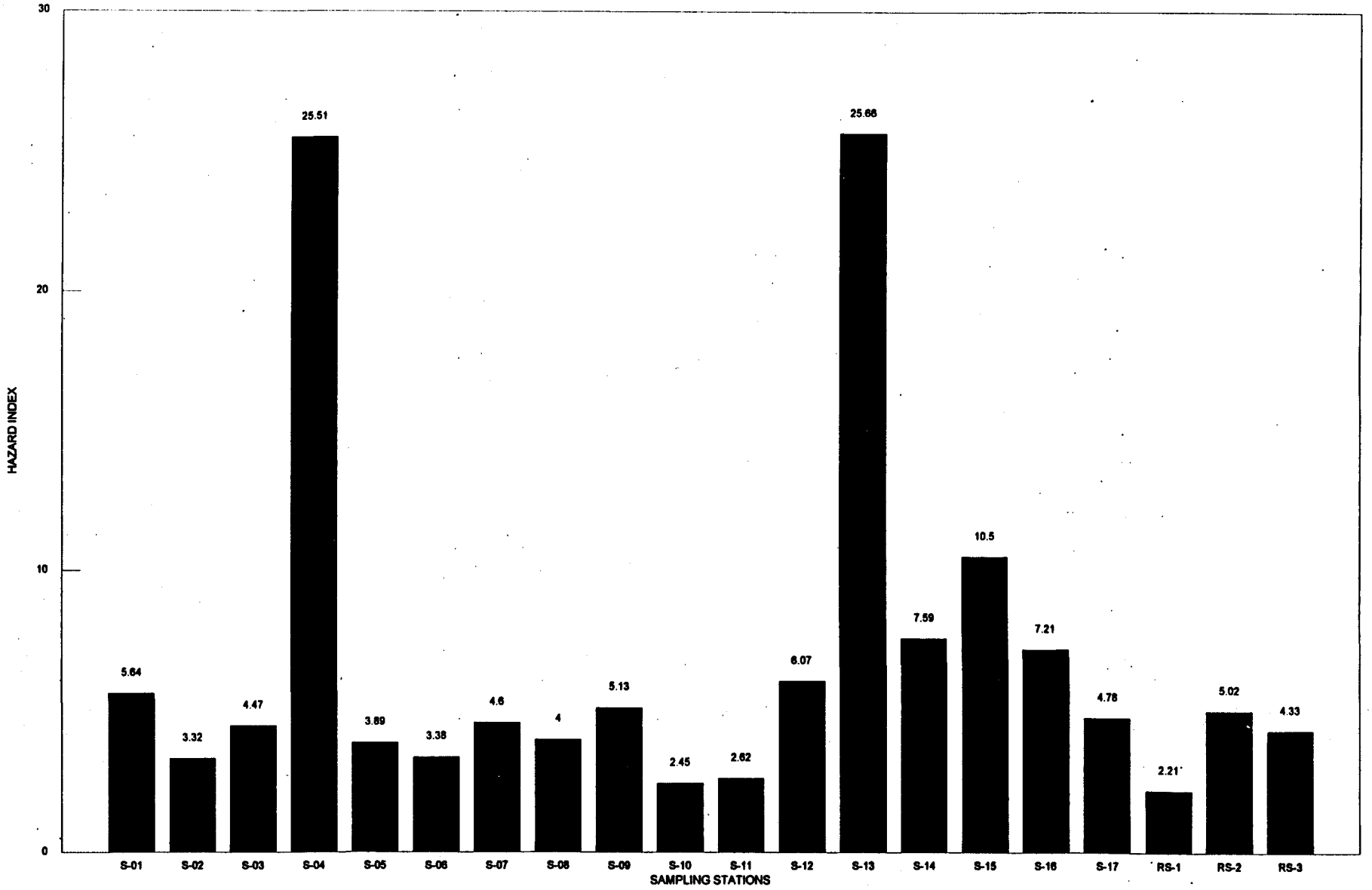


FIGURE 3-10

SUBSURFACE SEDIMENT (2.5)
HAZARD INDEX BASED ON ER-M



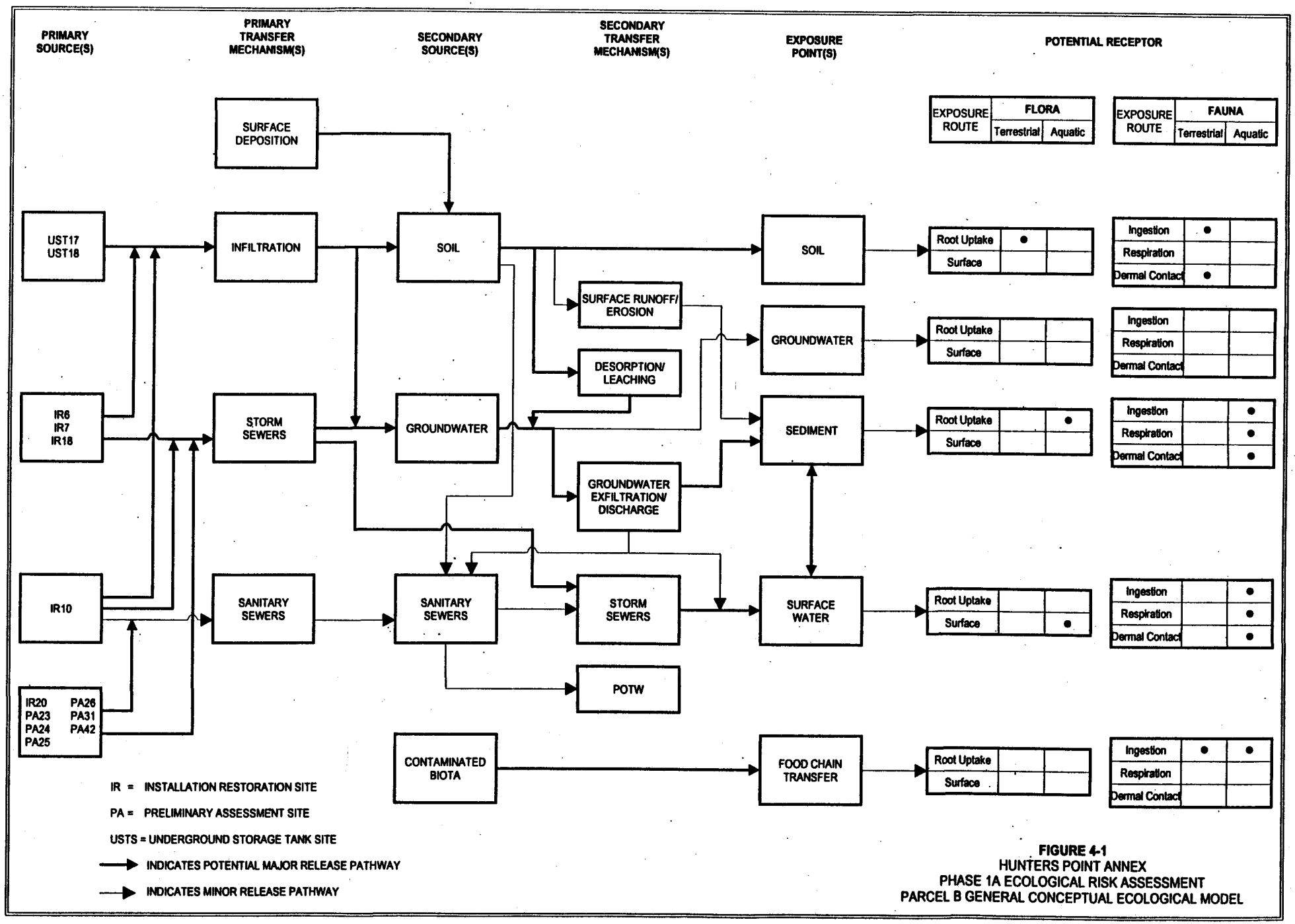


FIGURE 4-1
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
PARCEL B GENERAL CONCEPTUAL ECOLOGICAL MODEL

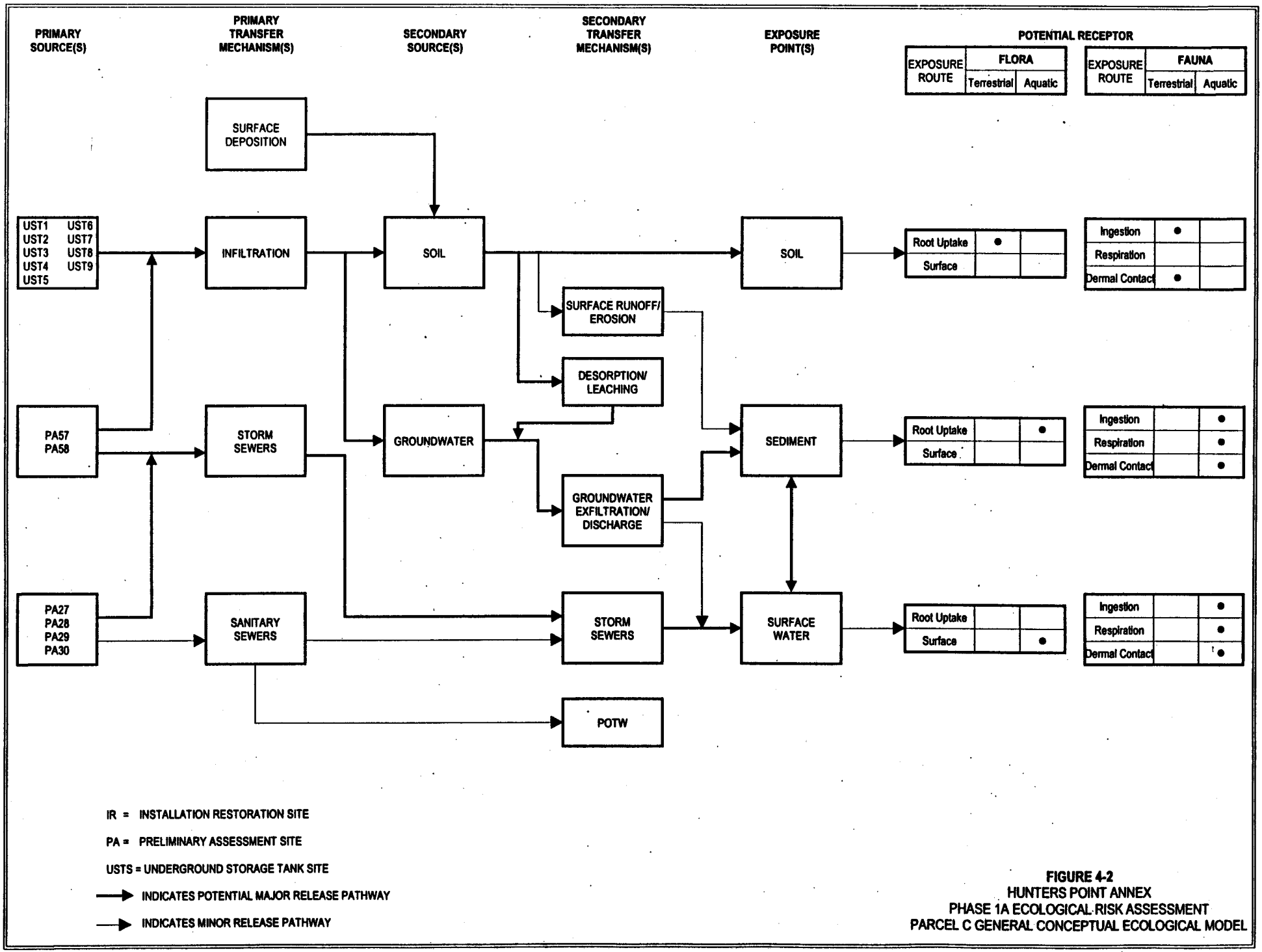


FIGURE 4-2
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
PARCEL C GENERAL CONCEPTUAL ECOLOGICAL MODEL

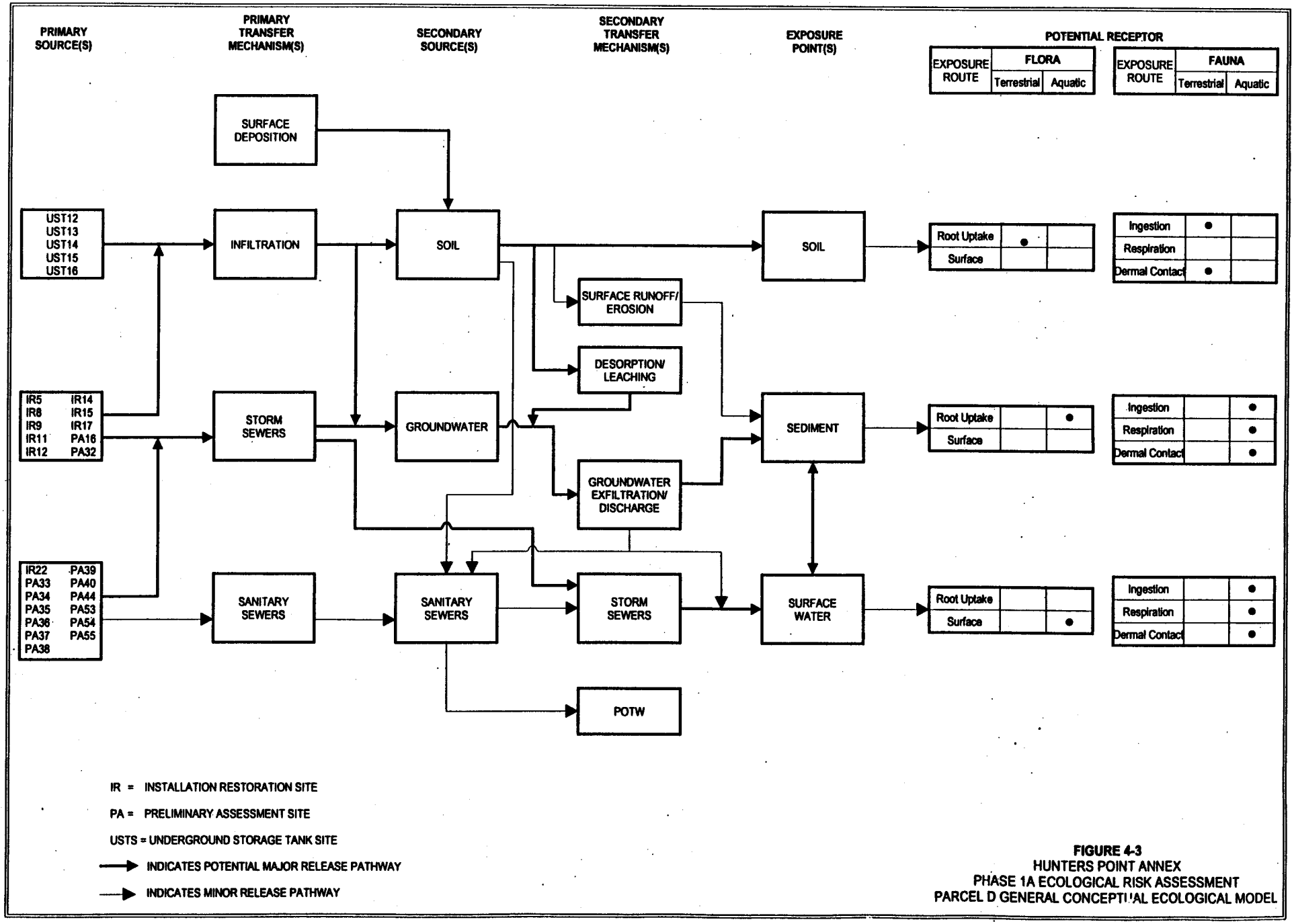


FIGURE 4-3
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
PARCEL D GENERAL CONCEPTUAL ECOLOGICAL MODEL

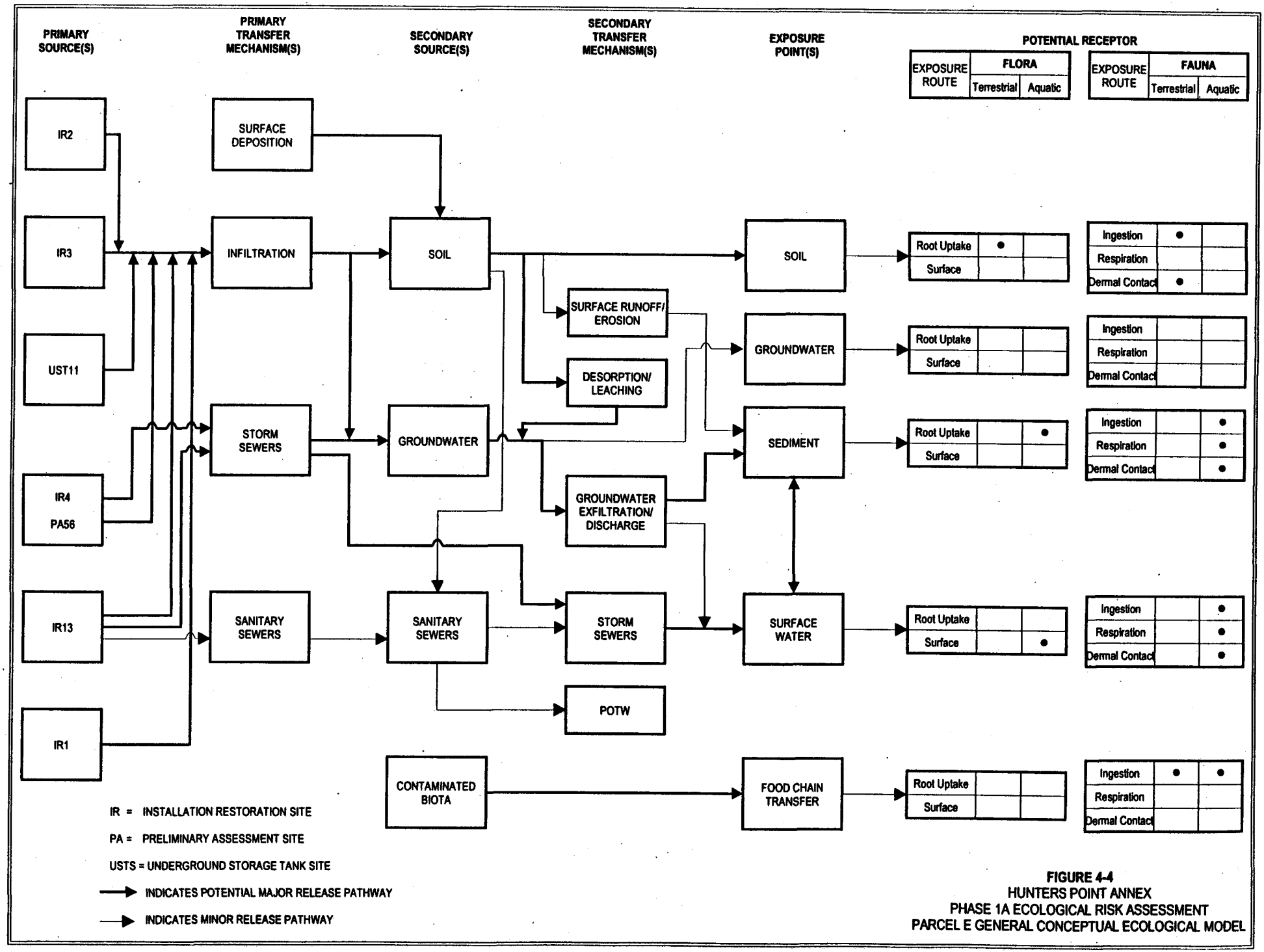
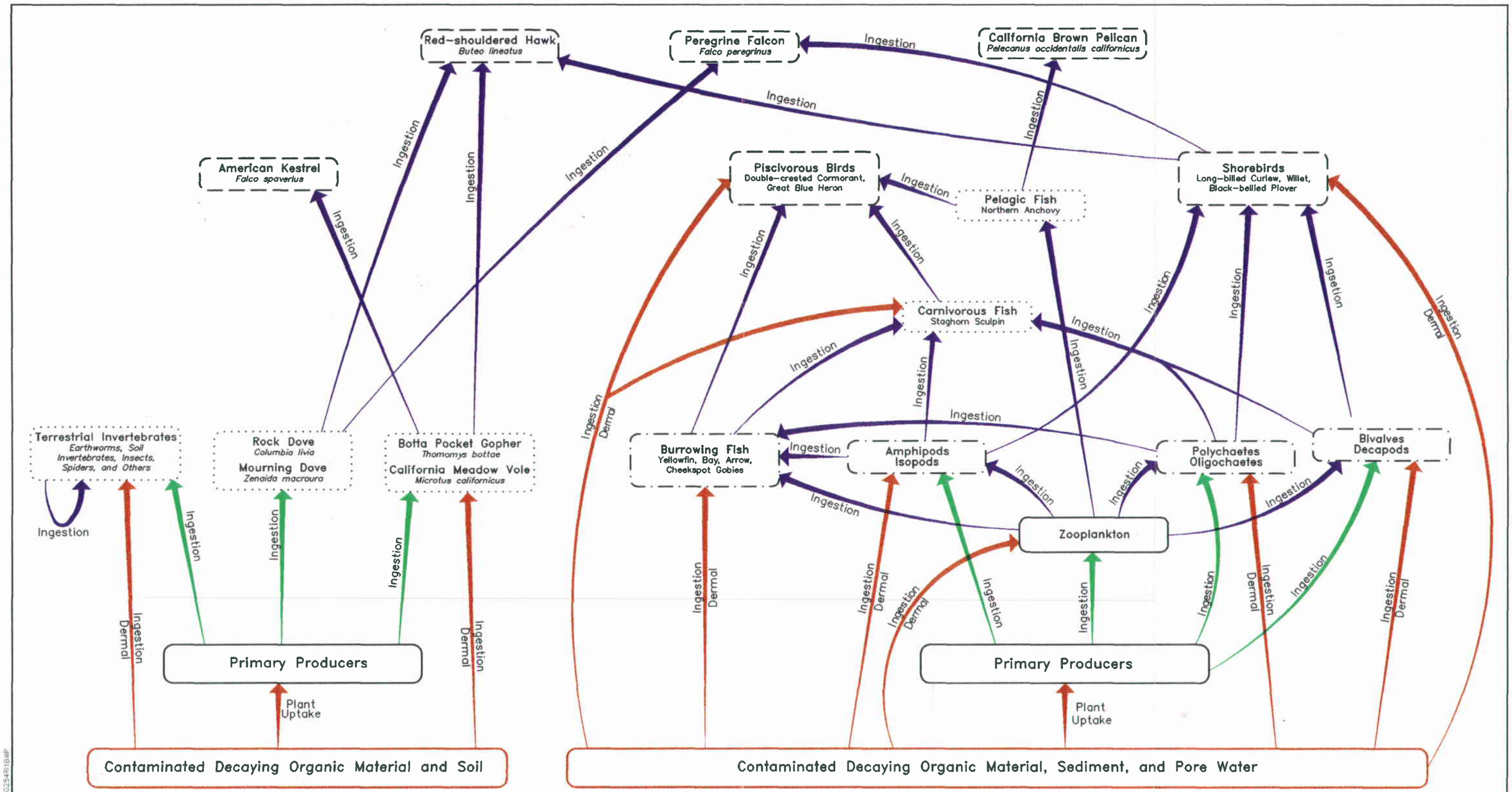


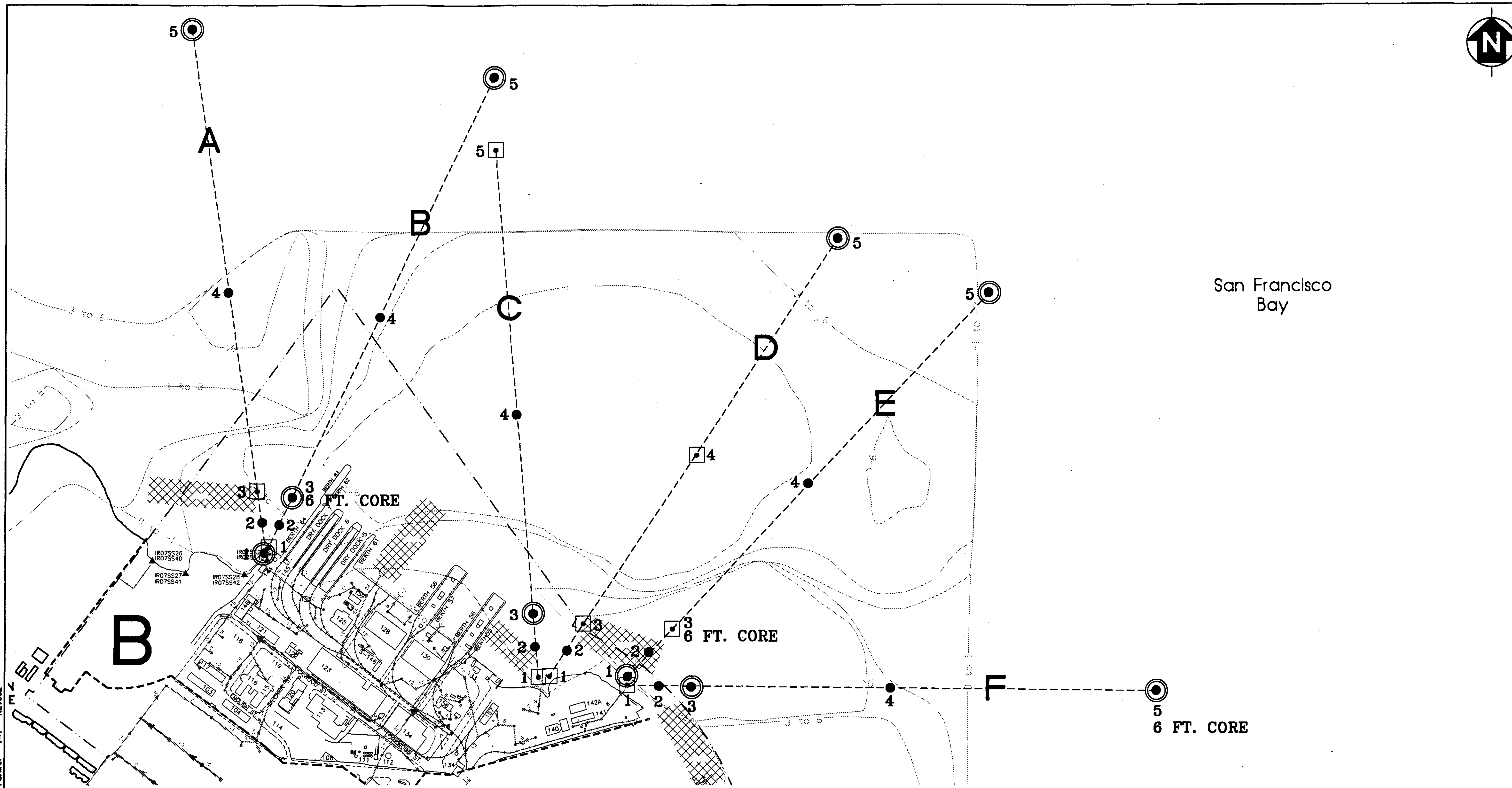
FIGURE 4-4
HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
PARCEL E GENERAL CONCEPTUAL ECOLOGICAL MODEL



CTI-WEB3.DWG - 05/31/95 - CFR - 044-025A01BWP

FIGURE 4-5

HUNTERS POINT ANNEX
PHASE 1A ECOLOGICAL RISK ASSESSMENT
CONTAMINANT EXPOSURE AND FLOW DIAGRAM
FOR TERRESTRIAL AND AQUATIC
ASSESSMENT AND MEASUREMENT ENDPOINTS



Legend

- STORM DRAIN, MANHOLE, FLOW ARROW, PIPE DIA., & OUTFALL
- ESAP SAMPLING LOCATIONS
- ▲ INTERTIDAL SAMPLING LOCATION
- TRANSECT
- FACILITY PARCEL BOUNDARY
- FACILITY BOUNDARY
- SEDIMENT DEPOSITION AND EROSION CONTOURS

● SURFACE SAMPLE–ANALYSIS:
1. BULK CHEMISTRY
2. AVS / SEM
3. GRAIN SIZE
4. TOTAL ORGANIC CARBON
5. PORE WATER CHEMISTRY

AMPHIPOD / ECHINODERM / MICROTOX SURFACE SAMPLE–ANALYSIS
1. SAME AS MICROTOX
2. 10 DAY AMPHIPOD WHOLE SEDIMENT
3. ECHINODERM DEVELOPMENT TEST

MICROTOX BIOASSAY SURFACE SAMPLE–ANALYSIS
1. MICROTOX BIOASSAY
2. AVS / SEM
3. GRAIN SIZE
4. TOTAL ORGANIC CARBON
5. BULK CHEMISTRY
6. PORE WATER CHEMISTRY

1 = STATION 0M FROM START OF TRANSECT
2 = STATION 60M FROM START OF TRANSECT
3 = STATION 120M FROM START OF TRANSECT
4 = STATION 500M FROM START OF TRANSECT
5 = STATION 1000M FROM START OF TRANSECT

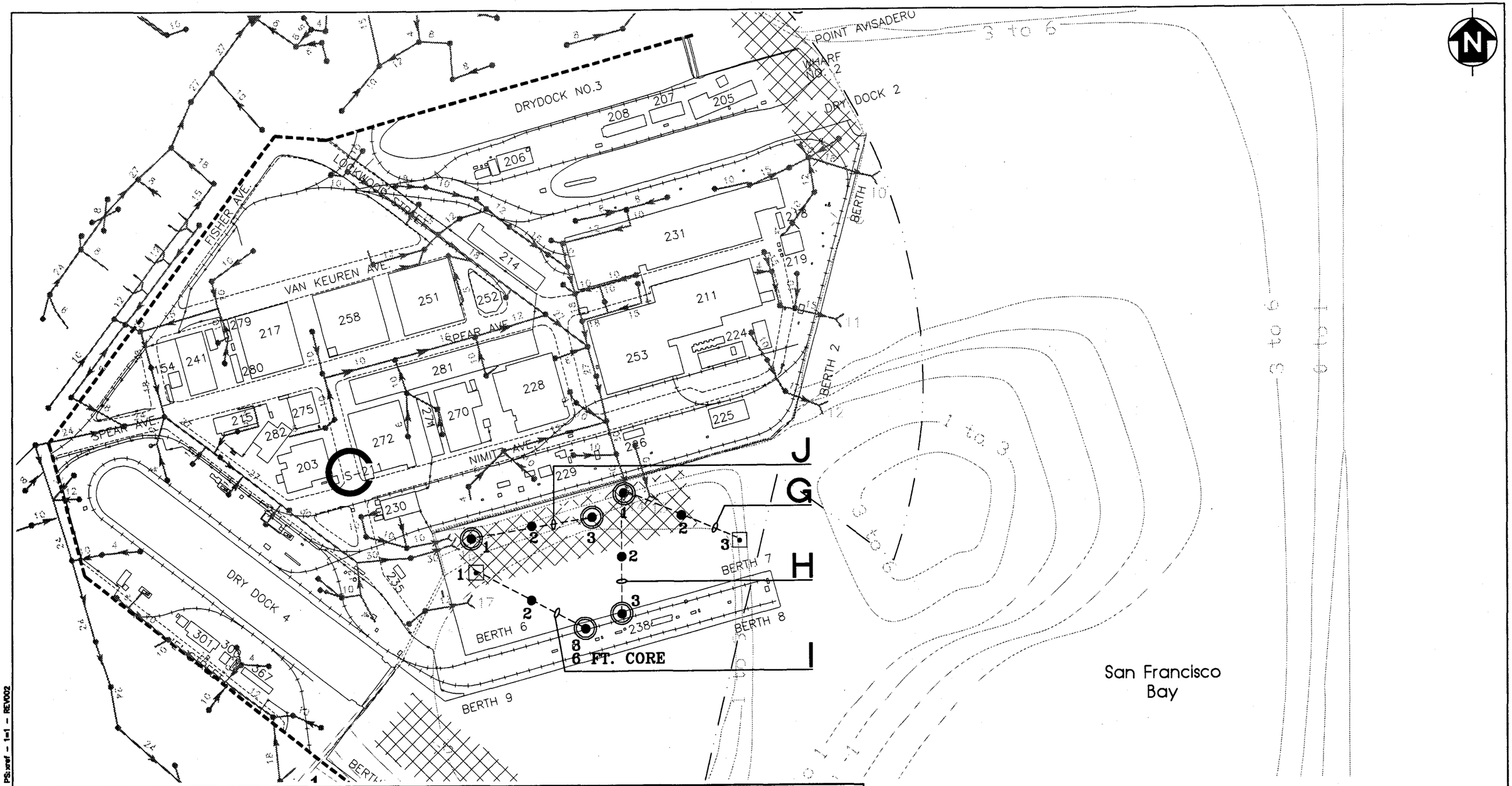
300' 0 300' 600'
SCALE: 1"=600'
SCALE 1" = 182 METERS

HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

FIGURE 6–1
SEDIMENT SAMPLING LOCATIONS OFFSHORE OF PARCEL B

PRC ENVIRONMENTAL MANAGEMENT, INC.

MA(SF)(044-0254)TRAN-B.DWG – 06/04/95 – PS:xref – 1=1 – REV002



Legend

- STORM DRAIN, MANHOLE, FLOW ARROW, PIPE DIA., & OUTFALL
- ESAP SAMPLING LOCATIONS
- TRANSECT
- FACILITY PARCEL BOUNDARY
- FACILITY BOUNDARY
- SEDIMENT DEPOSITION AND EROSION CONTOURS

- SURFACE SAMPLE–ANALYSIS:
  1. BULK CHEMISTRY
  2. AVS / SEM
  3. GRAIN SIZE
  4. TOTAL ORGANIC CARBON
  5. PORE WATER CHEMISTRY
- AMPHIPOD / ECHINODERM / MICROTOX SURFACE SAMPLE–ANALYSIS
  1. SAME AS MICROTOX
  2. 10 DAY AMPHIPOD WHOLE SEDIMENT
  3. ECHINODERM DEVELOPMENT TEST

- MICROTOX BIOASSAY SURFACE SAMPLE–ANALYSIS
  1. MICROTOX BIOASSAY
  2. AVS / SEM
  3. GRAIN SIZE
  4. TOTAL ORGANIC CARBON
  5. BULK CHEMISTRY
  6. PORE WATER CHEMISTRY

1 = STATION 0M FROM START OF TRANSECT
2 = STATION 60M FROM START OF TRANSECT
3 = STATION 120M FROM START OF TRANSECT

150' 0 150' 300'
SCALE: 1"=300'
SCALE 1" = 91 METERS

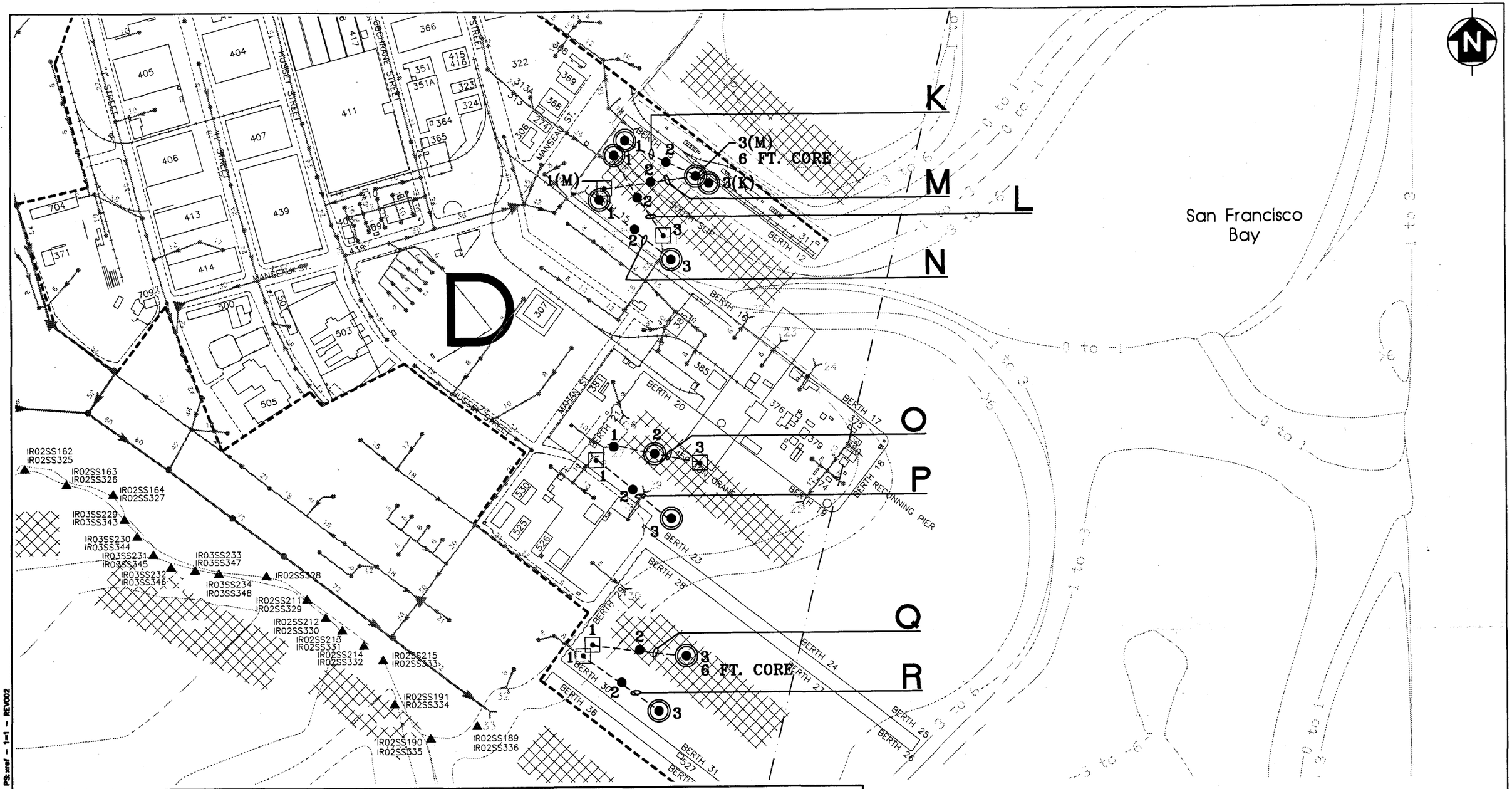
HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

FIGURE 6–2

SEDIMENT SAMPLING LOCATIONS OFFSHORE OF PARCEL C

PRC ENVIRONMENTAL MANAGEMENT, INC.

M:\(SF)\044-0254\TRAN-CLOWG - 06/04/95 - PS:xref - 1=1 - REV002



Legend

- STORM DRAIN, MANHOLE, FLOW ARROW, PIPE DIA., & OUTFALL
- ESAP SAMPLING LOCATIONS
- ▲ INTERTIDAL SAMPLING LOCATION
- TRANSECT
- FACILITY PARCEL BOUNDARY
- FACILITY BOUNDARY
- SEDIMENT DEPOSITION AND EROSION CONTOURS

- ● SURFACE SAMPLE–ANALYSIS:
  1. BULK CHEMISTRY
  2. AVS / SEM
  3. GRAIN SIZE
  4. TOTAL ORGANIC CARBON
  5. PORE WATER CHEMISTRY
- ⊡ AMPHIPOD / ECHINODERM / MICROTOX SURFACE SAMPLE–ANALYSIS
  1. SAME AS MICROTOX
  2. 10 DAY AMPHIPOD WHOLE SEDIMENT
  3. ECHINODERM DEVELOPMENT TEST
- ⊙ MICROTOX BIOASSAY SURFACE SAMPLE–ANALYSIS
  1. MICROTOX BIOASSAY
  2. AVS / SEM
  3. GRAIN SIZE
  4. TOTAL ORGANIC CARBON
  5. BULK CHEMISTRY
  6. PORE WATER CHEMISTRY

1 = STATION 0M FROM START OF TRANSECT
2 = STATION 60M FROM START OF TRANSECT
3 = STATION 120M FROM START OF TRANSECT

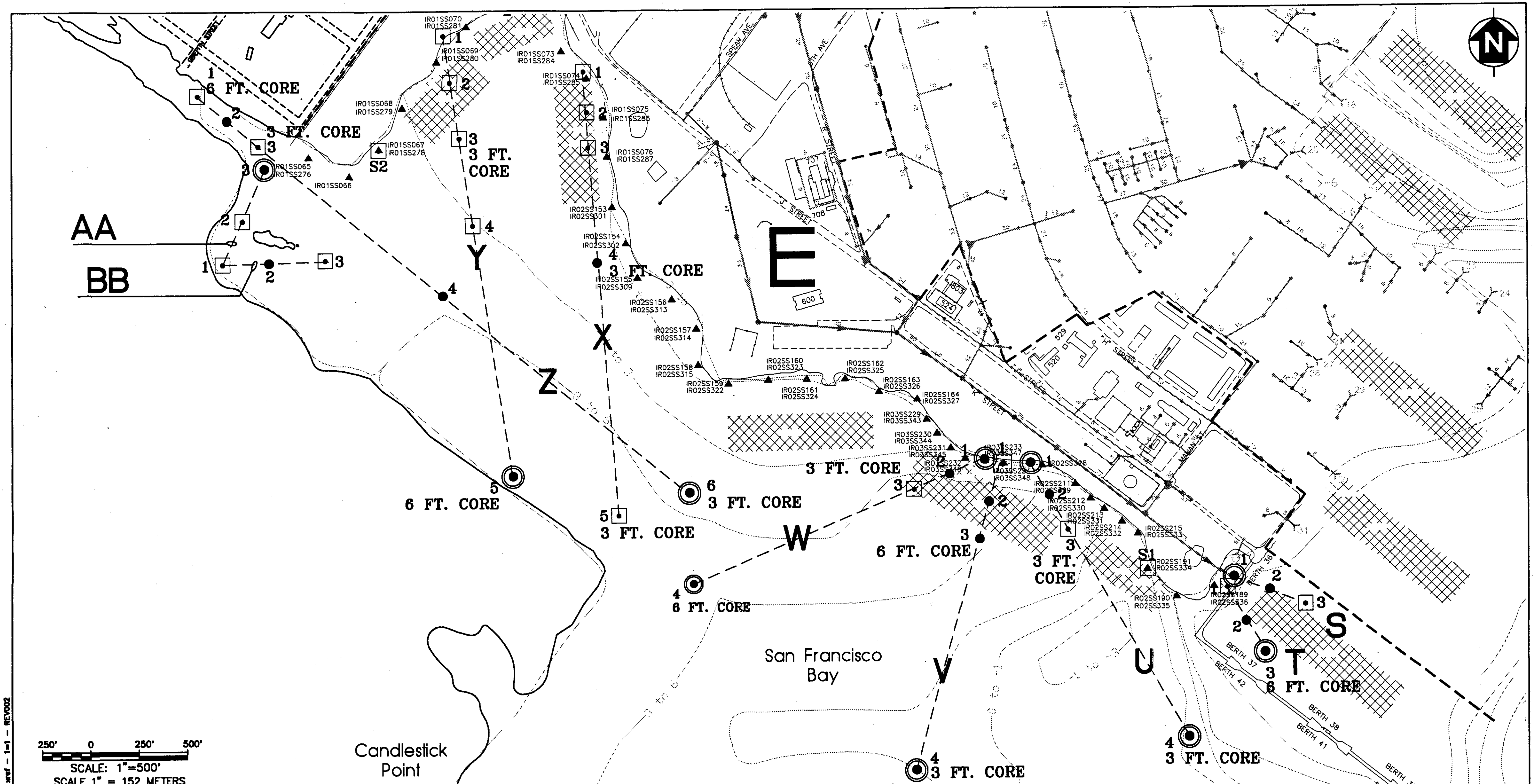
200' 0 200' 400'
SCALE: 1"=400'
SCALE 1" = 121 METERS

HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

FIGURE 6–3
SEDIMENT SAMPLING LOCATIONS OFFSHORE OF PARCEL D

PRC ENVIRONMENTAL MANAGEMENT, INC.

M:\(SF)\044-0254\TRAN-D.DWG - 06/04/93 - PS:xref - 1=1 - REV002



Legend

- STORM DRAIN, MANHOLE, FLOW ARROW, PIPE DIA., & OUTFALL
- ESAP SAMPLING LOCATIONS
- ▲ INTERTIDAL SAMPLING LOCATION
- TRANSECT
- FACILITY PARCEL BOUNDARY
- FACILITY BOUNDARY
- SEDIMENT DEPOSITION AND EROSION CONTOURS

● SURFACE SAMPLE-ANALYSIS:
1. BULK CHEMISTRY
2. AVS / SEM
3. GRAIN SIZE
4. TOTAL ORGANIC CARBON
5. PORE WATER CHEMISTRY

⊡ AMPHIPOD / ECHINODERM / MICROTOX SURFACE SAMPLE-ANALYSIS
1. SAME AS MICROTOX
2. 10 DAY AMPHIPOD WHOLE SEDIMENT
3. ECHINODERM DEVELOPMENT TEST

⊙ MICROTOX BIOASSAY SURFACE SAMPLE-ANALYSIS
1. MICROTOX BIOASSAY
2. AVS / SEM
3. GRAIN SIZE
4. TOTAL ORGANIC CARBON
5. BULK CHEMISTRY
6. PORE WATER CHEMISTRY

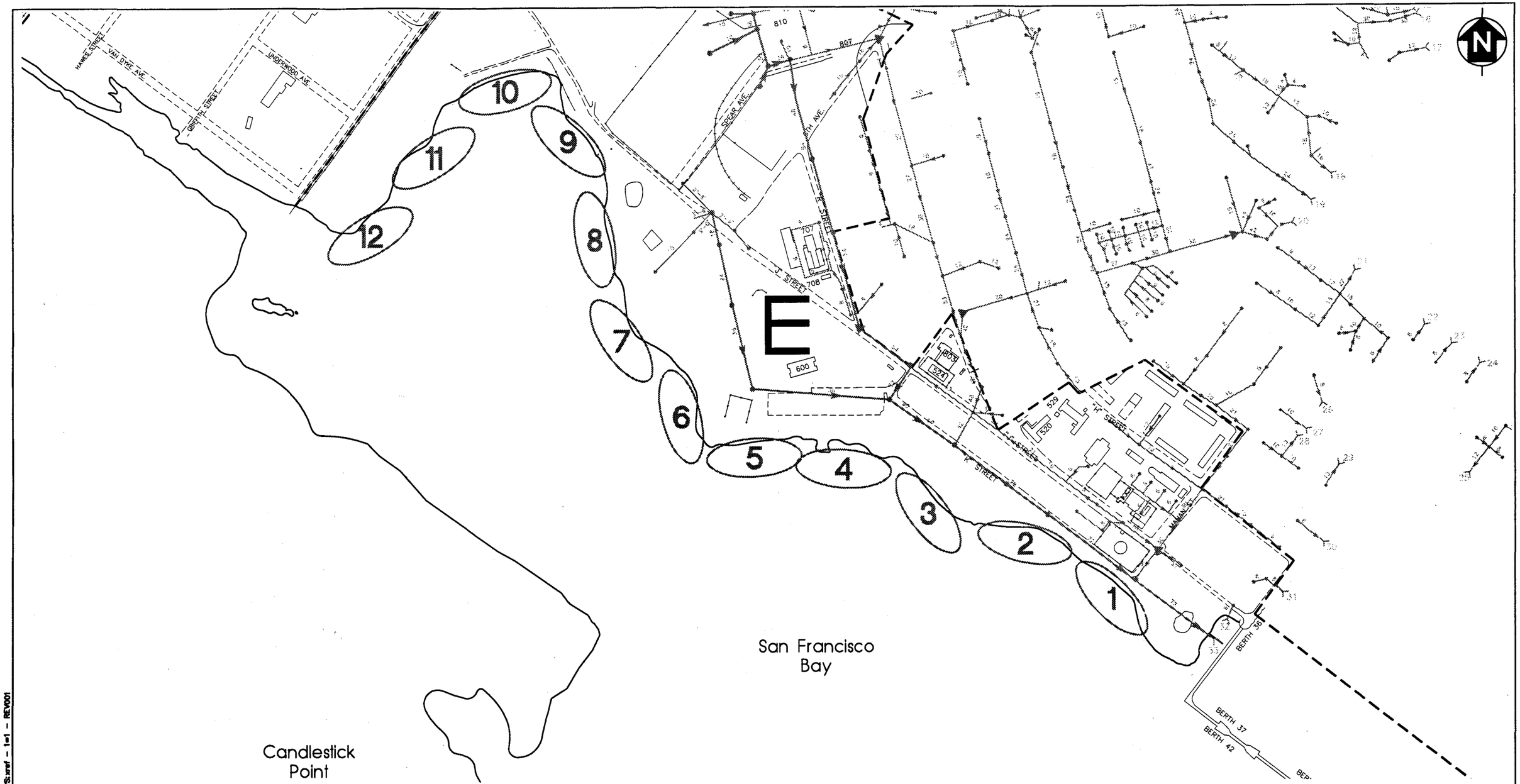
1 = STATION 0M FROM START OF TRANSECT
2 = STATION 60M FROM START OF TRANSECT
3 = STATION 120M FROM START OF TRANSECT
4 = STATION 500M FROM START OF TRANSECT
5 = STATION 700M FROM START OF TRANSECT
6 = STATION 1000M FROM START OF TRANSECT

HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

FIGURE 6-4
SEDIMENT SAMPLE LOCATIONS OFFSHORE OF PARCEL E

PRC ENVIRONMENTAL MANAGEMENT, INC.

MU(SF)(044-0254)TRAN-E.DWG - 08/04/95 - PS:xref - 1=1 - REV002



Legend

- STORM DRAIN, MANHOLE, FLOW ARROW, PIPE DIA., & OUTFALL
- (1) TISSUE RESIDUE SAMPLE AREA
- FACILITY PARCEL BOUNDARY
- FACILITY BOUNDARY

250' 0 250' 500'
SCALE: 1"=500'
SCALE 1" = 152 METERS

HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

FIGURE 6-5
TISSUE RESIDUE SAMPLE LOCATIONS

PRC ENVIRONMENTAL MANAGEMENT, INC.

M:\(SF)\(044-025A)\TISSUE.DWG - 06/06/95 - PS:xref - 1=1 - REV001

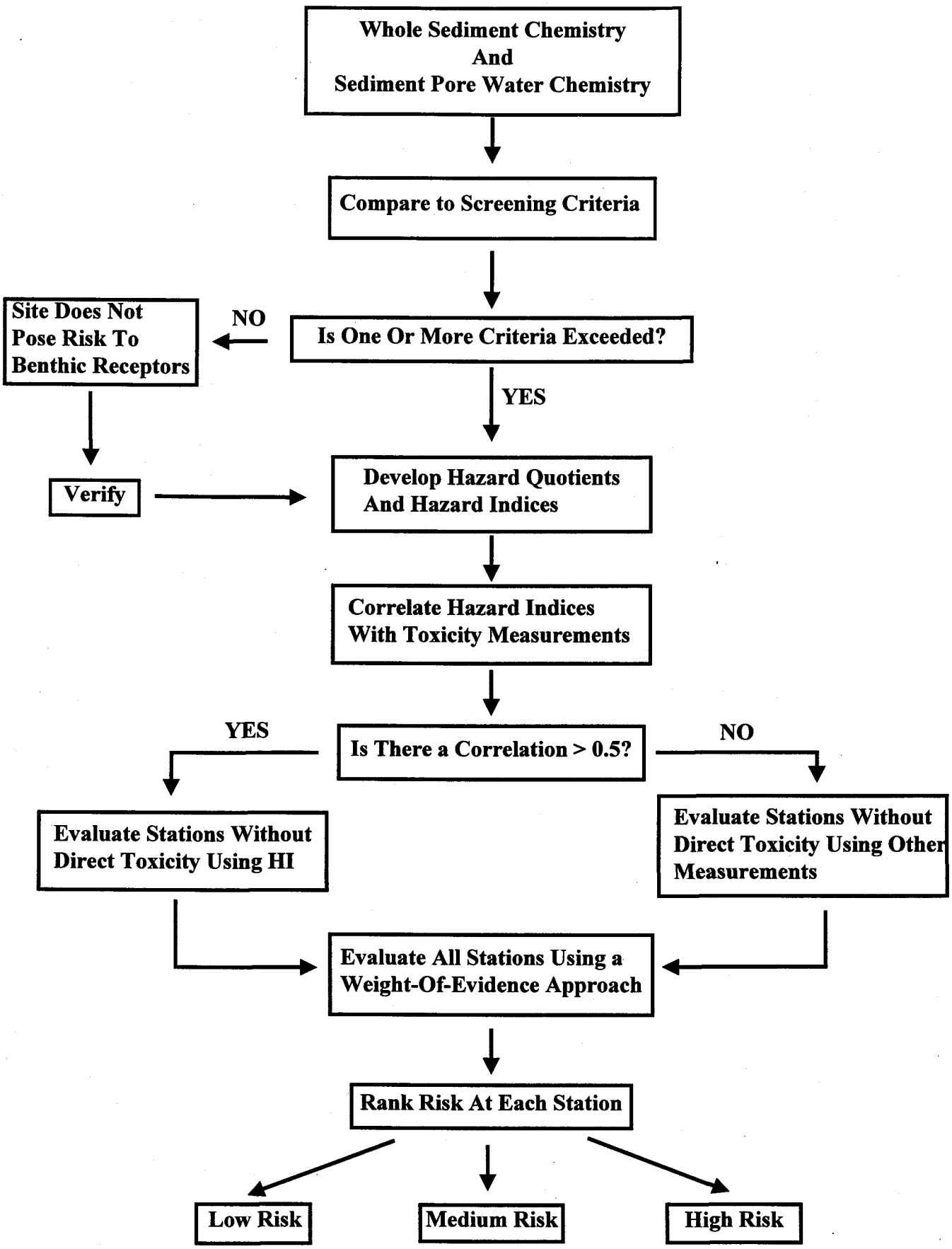
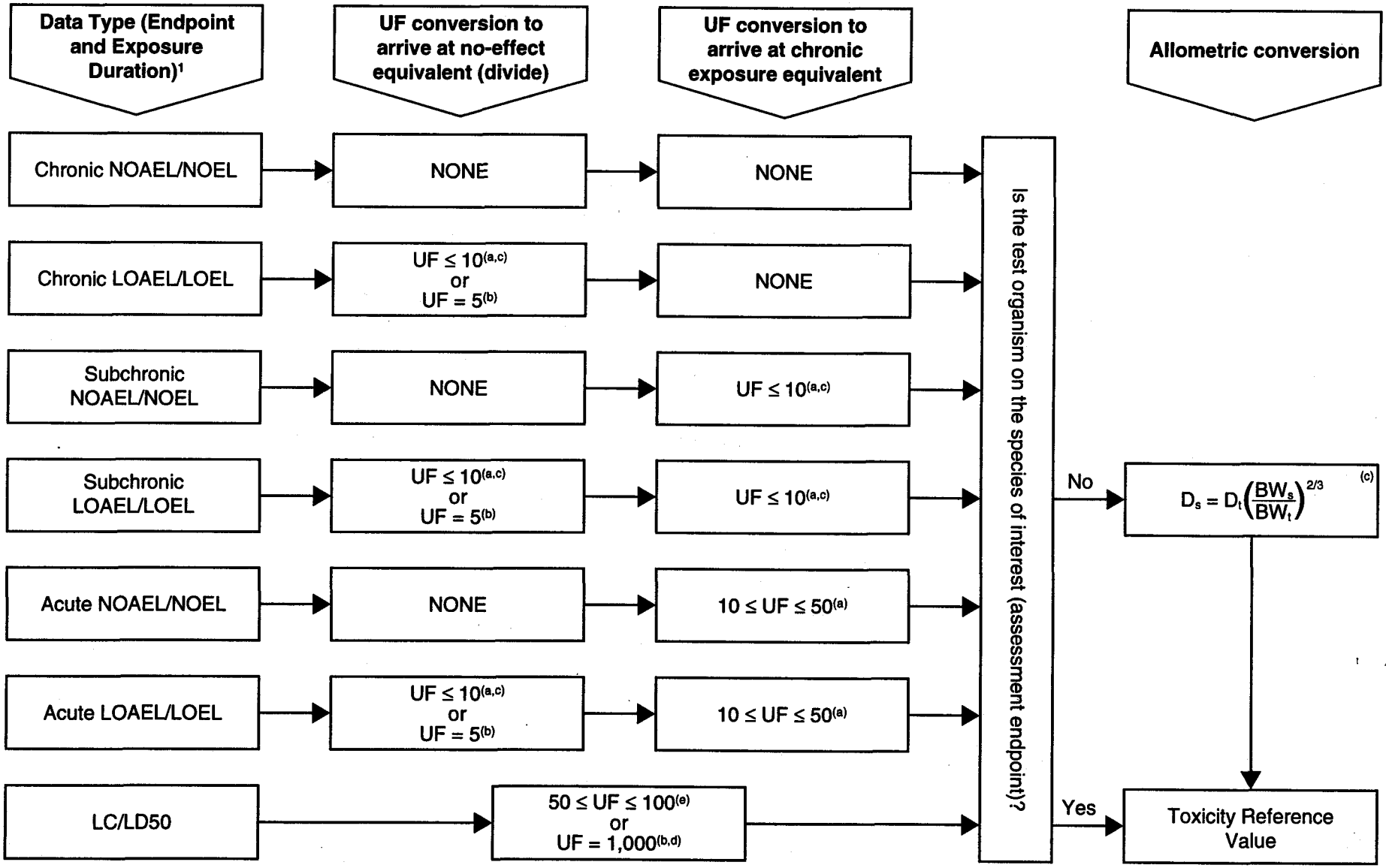


FIGURE 8-1

BENTHIC RISK CHARACTERIZATION

Figure 8-2
Flowchart for Derivation of Toxicity Reference Values



Notes:

1 = All data must be in dose units = mg/kgbw-day. Convert if necessary.

a = Calabrese and Baldwin (1993), page 89; **b** = EPA (1993), Rocky Mountain Arsenal Case Study page 8-A7; **c** = Opresko, and others (1993) page 6;
d = Calabrese and Baldwin (1993), page 52; **e** = Calabrese and Baldwin (1993), page 51-60

UF = Uncertainty Factor, $\mathbf{D_s}$ = Unknown Dose for species of interest, $\mathbf{D_t}$ = Known Dose for test organism, $\mathbf{BW_s}$ = Body weight for species of interest, $\mathbf{BW_t}$ = Body weight for test organism

Note: Rocky Mountain Arsenal case study treats acute LOAEL/LOEL the same as LC/LD50 in terms of UF application, where UF = 1,000

TABLES

TABLE 2-1

PARCEL AND SITE DESIGNATIONS AT HPA

Parcel	Site Number	Site Name
D, E	IR 38	Bldgs 500, 506, 507, 509, 510
D, E	IR 39	Bldgs 505, 507
B, C, D	IR 45	Steamlines
D, E	IR 47	Fuel Distribution Lines, Tank S-505
D, E	IR 48	Suspected Steamlines and Former Bldg 503
B, C	IR 49	Fuel Distribution Lines, Bldgs 203, 205
B, C, D, E	IR 50	Storm Drains and Sanitary Sewer Lines
B, C, D, E	IR 51	Former Transformer Sites
A	SI 19	Bldg 901
A	SI 41	Bldgs 816, 818
A	SI 43	Bldg 906
A	SI 45	Steamlines
A	SI 50	Storm Drains and Sanitary Sewer Lines
A	SI 51	Former Transformer Sites
A	UST 01	Bldg 813, Tank S-812
B	SI 31	Bldg 114
B	IR 06	Tank Farm
B	IR 07	Sub-base Area
B	IR 10	Battery and Electroplating Shop (Bldg 123)
B	IR 18	Waste Oil Disposal Site Behind Dago Mary's and Unnumbered Triple A Sites
B	IR 20	Bldg 156
B	IR 23	Bldgs 146, 161, 162
B	IR 24	Bldgs 124, 125, 128, 130
B	IR 25	Bldg 134
B	IR 26	Bldg 157 and Area XIV
B	IR 42	Bldgs 109, 113A
B	IR 46	Fuel Distribution Lines/Tank Farm
B	UST 02	Bldg 116, Tank S-135
B	UST 03	Bldg 118, Tank S-136

TABLE 2-1

PARCEL AND SITE DESIGNATIONS AT HPA
(Continued)

Parcel	Site Number	Site Name
C	SI 59	Bldg 224
C	IR 27	Bldg 205
C	IR 28	Bldgs 211/253, 219, 230, 231, 258, 270, 271, 281
C	IR 29	Bldgs 203, 217, 275, 279, 280, 282
C	IR 30	Bldg 241
C	IR 57	Drydock 4 Area
C	IR 58	Scrap Yard Near Bldg 258
C	UST 04	Bldg 203, Tank S-203
C	UST 05	Bldg 203, Tank S-209, 2-210
C	UST 06	Bldg 203, Tank S-211, S-212, S-213
C	UST 07	Bldg 205, Tank HPA-06
C	UST 08	Bldg 205, S-214
C	UST 09	Bldg 211, Tank HPA-01
C	UST 10	Bldg 231, Tank HPA-11
C	UST 12	Bldg 231, Tank HPA-12
C	UST 13	Bldg 231, Tank HPA-16
C	UST 14	Bldg 231, Tank HPA-17
C	UST 15	Bldg 251, Tank S-219
C	UST 16	Bldg 251, Tank S-251
C	UST 17	Bldg 253, Tank HPA-02, HPA-03
C	UST 18	Bldg 253, Tank HPA-04, HPA-05
C	UST 19	Bldg 253, Tank S-001, S-002, S-003, S-004
C	UST 20	Bldg 271, Tank S-215
C	UST 21	Bldg 272, Tank HPA-07
C	UST 22	Bldg 281, Tank HPA-33, HPA-34
D	SI 16	Container Storage Area and Triple A Site 9
D	SI 60	Bldg 313A
D	SI 61	Bldg 313
D	SI 62	Bldg 351A
D	SI 63	Bldg 365

TABLE 2-1

PARCEL AND SITE DESIGNATIONS AT HPA
(Continued)

Parcel	Site Number	Site Name
D	SI/IR 33	Bldgs 302, 302A, 304, 364, 411, 418
D	SI/IR 34	Bldgs 351, 366
D	SI/IR 35	Bldgs 274, 306 -- Area Bounded by Manseau, Morell, E Streets
D	SI/IR 36	Bldgs 371, 400, 404A, 405, 406, 413, 414, 704, and Area West of Bldg 405
D	SI/IR 37	Bldgs 401, 423, 435, 436
D	SI/IR 44	Area Near Bldgs 408, 409, 4110, 438
D	SI/IR 53	Bldg 525, 530
D	SI/IR 55	Bldg 307
D	IR 08	Bldg 503, PCB Spill Area
D	IR 09	Pickling and Plate Yard
D	IR 17	Drum Storage & Disposal Site, Triple A Sites 10 and 11
D	IR 22	Bldg 368, 369
D	IR 32	Bldg 383 and Regunning Pier
D	UST 23	Bldg 304, Tank S-304, S-305
D	UST 24	Bldg 308, Tank HPA-308
D	UST 25	Bldg 435, Tank S-435(1), S-435(2)
D	UST 26	Bldg 505, Tank S-508
D	UST 27	Bldg 709, Tank S-711, S-712, S-713, S-714, S-715, HPA-14, HPA-15
E	SI 64	Bldg 508
E	SI 65	Bldg 517
E	SI 66	Bldg 507
E	SI 67	Bldg 520
E	SI 68	Bldg 510
E	SI 69	Bldg 529
E	SI 70	Bldg 708
E	SI/IR 40	Bldg 527 and Pier 2
E	SI/IR 52	Railroad Right of Way
E	SI/IR 54	Building 511A

TABLE 2-1

PARCEL AND SITE DESIGNATIONS AT HPA
(Continued)

Parcel	Site Number	Site Name
E	SI/IR 56	Area VII, Railroad Tracks
E	IR 01	Industrial Landfill and Triple A Sites 1 and 16
E	IR 02	Bay Fill Area: Triple A Sites 2, 13, 14, 17, 18, 19, excluding IR 03
E	IR 03	Oil Reclamation Ponds and Part of Triple A Site 17
E	IR 04	Scrap Yard and Triple A Site 3
E	IR 05	Old Transformer Storage Yard
E	IR 11	Bldg 512, Power Plant
E	IR 12	Disposal Trench and Salvage Yard; Triple A Sites 3 (Partial) and 4
E	IR 13	Old Commissary Site, Triple A Sites 6 and 7
E	IR 14	Oily Liquid Waste Disposal Site; Triple A Sites 6 and 7
E	IR 15	Oily Waste Ponds and Incineration Tank; Triple A Sites 12 and 13
E	UST 28	Bldg 811, Tank S-801, S-802

TABLE 2-2

ONSHORE HABITATS AND BIOTA

Habitat Type	Parcel/Location	Typical Plants	Typical Animals
Ruderal	*All parcels* Disturbed areas, parking lots, debris, abandoned structures primarily on fill material	Opportunistic weeds such as: sweet fennel, black mustard, willow-herb, brome grasses	Seed-eating birds such as: mourning dove, house finch, savannah sparrow, song sparrow Insect-eating birds such as: meadowlark, black phoebe, northern mockingbird Birds of prey such as: red-tailed hawk, peregrine falcon, American kestrel Small mammals such as: California ground squirrel, Botta's pocket gopher, meadow vole, black-tailed hare, red fox Omnivorous birds such as: scrub jay, American robin, Anna's hummingbird
Non-native Grassland	*Parcel A* On steep south slope of hillside with serpentinite outcrops	Exotic opportunistic species such as: wild oat, ripgut, fescue, star-thistle	Similar to those found in ruderal areas
Landscaped	*Parcel A* Surrounding abandoned housing, clubs, and office buildings	Ornamental trees such as: eucalyptus and pines, and shrubs Weedy grasses and herbs	Omnivorous birds such as: scrub jay, American robin, Anna's hummingbird Birds of prey such as: red-shouldered hawk, red-tailed hawk, American kestrel Small mammals such as: California ground squirrel, Botta's pocket gopher, meadow vole, black-tailed hare, red fox
Wetland	*Parcels E and B* Salt marsh within tidally influenced zone	Estuarine plants such as: pickleweed, salt grass, sedge	Shorebirds and waders such as: willet, killdeer, great blue heron, great egret Birds of prey such as: peregrine falcon, red-shouldered hawk Aquatic and terrestrial invertebrates

TABLE 2-3

PLANTS RECENTLY OBSERVED AT HPA

Family	Common Name	Species Name	CA Native	HLA[a] 9/91	WD[b] 7/91	CNPS[c] 4/89	Habitat
Pinaceae	Monterey Pine	*Pinus radiata*	Yes	x			Ornamental, pine and oak woodlands
	Scots Pine	*Pinus sylvestris*		x			Pine and oak woodlands
Taxodiaceae	Redwood	*Sequoia sempervirens*	Yes	x			Redwood forest
Cupressaceae	Deodar Cypress	*Cedrus deodara*		x			
	Monterey Cypress	*Cupressus macrocarpa*	Yes	x			Ornamental, cypress forest
Papaveraceae	California Poppy	*Eschscholzia californica*	Yes	x			Coastal bluffs, grassy hills, rocky ridges
Platanaceae	Western Sycamore	*Platanus racemosa*	Yes	x			Streamsides, canyons
Moraceae	Rubber Tree	*Ficus elastica*		x			Moist, disturbed areas
Aizoceae	Ice Plant	*Carpobrotus edulis*	No	x			Coastal areas, sand dunes
Cactaceae	Indian Fig	*Opuntia ficus-indica*	No	x			Dry, coastal areas
Chenopodiaceae		*Atriplex fatua*			x	x	
	Spear Oracle	*Atriplex patula*	Yes	x			Salt marsh
	Australian Saltbush	*Atriplex semibaccata*	No	x			Waste ground
		Chenopodiaceae sp.	No			x	Disturbed habitat
	Pickleweed	*Salicornia subterminalis*	Yes	x			Coastal salt marshes
	Pickleweed	*Salicornia virginica*	Yes	x	x	x	Coastal salt marshes
	Sea Blight	*Suaeda calceoliformis*	Yes	x			Coastal salt marshes
Caryophyllaceae	Sand Spurrey	*Spergularia marina*	Yes	x			
		Spergularia sp.				x	Wet ground
Polygonaceae		*Eriogonum nudum*	Yes			x	Grassy, open areas
	Dooryard Knotweed	*Polygonum arenastrum*	No	x			Disturbed ground, sidewalks, gardens
	Curly Dock	*Rumex crispus*	No	x			Low, weedy places, marshes
		Rumex salicifolius var.	Yes	x		x	Open hills, clayey soil
	Sea Lavender	*Limonium californicum*	Yes	x	x	x	Moist ground
Malvaceae	High Mallow	*Malva sylvestris*	No	x			Roadsides, waste areas
Tamaricaceae	Tamarisk	*Tamarix* spp.	No	x			Washes, flats, roadsides
Frankeniaceae	Alkali Heath	*Frankenia salina*	Yes	x		x	Saltmarsh

TABLE 2-3

PLANTS RECENTLY OBSERVED AT HPA (Continued)

Family	Common Name	Species Name	CA Native	HLA[a] 9/91	WD[b] 7/91	CNPS[c] 4/89	Habitat
Brassicaceae	Madwort	*Alyssum* spp.		x			Roadsides, disturbed and waste areas
	Black Mustard	*Brassica nigra*	No	x			Roadsides, disturbed sites
	Sea Rocket	*Cakile maritima*	No	x			Beach dunes
	Wild Radish	*Raphanus sativus*	No	x	x		Disturbed areas, fields, roadsides
Pittosporaceae	Japanese Pittosporum	*Pittosporum tobira*	No	x			Ornamental
Crassulaceae	Live Forever	*Dudleya* sp.	Yes	x			Rocky outcrops, coastal bluffs, open areas, slopes
Rosaceae	Cotoneaster	*Cotoneaster lactea*	Yes	x			Disturbed area (often near dwellings)
	Toyon	*Heteromeles arbutifolia*	Yes	x		x	Oak woodland
	Firethorn	*Pyracantha koidzumii*		x			Ornamental
	California Rose	*Rosa californica*	Yes	x			
	Blackberry	*Rubis thirsifolia*		x			
Fabaceae	Kangaroo Thorn	*Acacia paradoxa*	No	x			
	Green Wattle	*Acacia decurrens*	No	x			Near landscaped areas
	French Broom	*Genista monspessulana*	No	x			Weed, waste ground
	Birdfoot Trefoil	*Lotus corniculatus*	No	x			Open, disturbed areas
	Pinole Clover	*Trofolium bifidum*	No	x			Open grassy areas, forests
Myrtaceae		*Eucalyptus polyanthemos*	No	x			
		Eucalyptus sideroxylon	No	x			
		Eucalyptus globulus	No	x			Spontaneous in vicinity landscaped areas
Onagraceae		*Epilobium branchycarpum*	Yes			x	Weed, wet places
Euphorbiaceae	Dove Weed	*Eremocarpus setigerus*	Yes	x			Dry open disturbed areas
Anacardiaceae	Peruvian Pepper Tree	*Schinus molle*	No	x			Washes, slopes, abandoned fields
Linaceae		*Linum* spp.				x	Grassland, disturbed areas, slopes
Simaroubaceae	Tree of Heaven	*Ailanthus altissima*	No	x			Disturbed urban areas, waste areas
Apiaceae	Sweet Fennel	*Foeniculum vulgare*	Yes	x	x		Roadsides, waste areas
Convolvulaceae		*Calystegia occidentalis*	Yes			x	Dry slopes, woodland
		Calystegia subacaulis	Yes			x	Dry open scrub, woodland

TABLE 2-3

PLANTS RECENTLY OBSERVED AT HPA (Continued)

Family	Common Name	Species Name	CA Native	HLA[a] 9/91	WD[b] 7/91	CNPS[c] 4/89	Habitat
Cuscutaceae		*Cuscuta salina v. major*	Yes			x	
Lamiaceae	Rosemary	*Rosemarinus officinalis*		x			
Plantaginaceae	English Plantain	*Plantago lanceolata*	No	x			Roadsides, disturbed areas
	Maritime Plantain	*Plantago maritima*	Yes	x			
Valerianaceae	Jupiter's Beard	*Centranthus ruber*	No	x			Waste ground, rocky slopes, gardens
Asteraceae	Bur Sage	*Ambrosia dumosa*	Yes	x		x	Creosote-brush scrub land
		Ambrosia chamissonis	Yes				
	Yellow Star Thistle	*Centaurea solstitialis*	No	x			Roadside, waste areas
	Bull Thistle	*Cirsium vulgare*	No	x			Weedy, roadside, disturbed
	Horseweed	*Conyza canadensis*	Yes	x			Weed, widespread
	Weedy Everlasting	*Gnaphalium luteo-album*	No	x			Disturbed areas
	Gum-Weed	*Grindelia camporum*	Yes	x			Open grassy, rocky slopes, clayey flats
		Grindelia hirsutula	Yes			x	Open grassy hills
	Telegraph Weed	*Heterotheca grandiflora*	Yes	x			Disturbed areas, dry streams
	Hairy Cat's-Ear	*Hypochaeris radicata*	No	x			Grassy, natural, waste, cultivated ground
		Jaumea carnosa	Yes			x	
	Bristly Ox-Tongue	*Picris echioides*	No	x			Weed, waste ground, open natural slopes
	Milk Thistle	*Silybum marianum*	No	x			Weed, wild or waste ground
	Cocklebur	*Xanthanium strumarium*	Yes	x			Disturbed areas
Arecaceae	Mexican Fan Palm	*Wahingtonia robusta*		x			Moist areas
Juncaceae	Toad Rush	*Juncus bufonis*	Yes			x	Moist, wild, disturbed soil
		Juncus leseurii	Yes			x	Wet slopes, flats, sandy marshes
Cyperaceae	Umbrella Sedge	*Cyperus laevigatus*	Yes	x			Brackish wet soils
		Scirpus maritimu	Yes			x	
		Scirpus robustus	Yes		x	x	Moist soils

TABLE 2-3

PLANTS RECENTLY OBSERVED AT HPA (Continued)

Family	Common Name	Species Name	CA Native	HLA[a] 9/91	WD[b] 7/91	CNPS[c] 4/89	Habitat
Poaceae	Wild Oat	*Avena fatua*	No	x		x	Weed, waste ground, grassy hillsides
	Rattlesnake Grass	*Bromus brizaeformis*	No	x			Disturbed areas
	Foxtail Chess	*Bromus madritensis* spp. *rubens*	No	x			Waste ground, dry slopes
	Pampas Grass	*Cortaderia selloana*	No	x			Disturbed area, ornamental
	Saltgrass	*Distichlis semibaccata*	Yes		x	x	Marshes
	Saltgrass	*Distichlus spicata*	Yes	x		x	Alkaline soils
	Mediterranean Barley	*Hordeum murinum* spp. *gussoneanum*	No	x			Waste ground, moist grassy flats
	Farmer's Foxtail	*Hodreum murinum* spp. *leporinum*	No	x			Waste ground, grassy slopes, flats
	Alkali Rye Grass	*Leymus triticoides*	Yes	x			Brush open slopes and flats
	Perennial Ryegrass	*Lolium perenne*	No	x			Ornamental, waste ground, moist ground
	Cord Grass	*Spartina foliosa*	Yes		x	x	
	St. Augustine Grass	*Stenotaphrum secundatum*	No	x			Field, roadside
	Spear Grass	*Stipa (Nassella) pulchra*	Yes			x	Grassland, oak woodland
	Foxtail Fescue	*Vulpia myuros*	No	x			Dry, disturbed area
Liliaceae	Century Plant	*Agave americana*		x			Coastal bluffs, slopes
	Variegated Century Plant	*Agave americana* var. *variegata*		x			Coastal bluffs, slopes
Iridaceae	Blue-Eyed Grass	*Sisyrinchium bellum*	Yes			x	Moist grassy areas

Notes:

[a] Observed on HPA during a terrestrial survey conducted by HLA (1991).

[b] Observed during the wetland delineation performed by U.S. Naval Facilities Engineering Command, Western Division (WESTDIV 1991).

[c] Observed during a survey of HPA, India Basin, and Islais Creek conducted by the California Native Plant Society (Sigg 1994).

Blank cells in the California Native Category indicate that no information was available.

TABLE 2-4

ABUNDANT OFFSHORE BIOTA AT HPA

Species	Total No. Individ.	Average No. Individuals/Sample		
		South Basin	India Basin	Candlestick
Subtidal Epibenthic Sampling Stations	**N=10**	**N=6**	**N=2**	**N=2**
Typosyllis hyalina (polychaete)	16,903	957	4,647	933
Caprella scaura (amphipod)	12,304	1,580	115	1,296
Musculus senhousia (bivalve)	9,915	3,320	569	1,070
Exogone lourei (polychaete)	8,760	1,121	112	904
Rhacotropis spp. (amphipod)	5,432	1,219	88	1,410
Ampelisca abdita (amphipod)	4,677	672	195	128
Subtidal Benthic Sampling Stations	**N=33**	**N=25**	**N=4**	**N=4**
Hemileucon hinumensis (crustacean)	1,829	63.6	38	21.5
Tubificidae (tube worm)	1,741	57	69	9.3
Ampelisca abdita (amphipod)	1,420	15.2	241.3	76
Nematoda spp. (worm)	599	23	7.3	0
Musculus senhousia (bivalve)	488	8.8	67	0.3
Corophium heteroceratum (amphipod)	422	13.2	2.5	20.8
Intertidal Sampling Stations	**N=36**	**N=28**	**N=4**	**N=4**
Tapes japonica (bivalve)	335	10.7	1	8
Musculus senhousia (bivalve)	131	4.4	0	2
Mytilus edulis (bivalve)	115	4.1	0	0
Gemma gemma (bivalve)	82	2.9	0	0
Ostrea lurida (bivalve)	74	2.6	0	0
Macoma balthica (bivalve)	64	2.3	0	0
Demersal Fish Trawls	**N=10**	**N=6**	**N=2**	**N=2**
Engraulis mordax (anchovy)	1,800	77.3	165.5	511.5
Hyperprosopon ellipticum (surfperch)	39	4.5	3	3
Larval goby species	13	2	0	0.5

Most abundant species based on total number of individuals for all samples.

TABLE 3-1

SOIL CHEMICALS OF POTENTIAL CONCERN BY PARCEL

	Chemicals with 1% of Samples Exceeding RWQCB Basin Plan Criteria			
Contaminant	**Parcel B**	**Parcel C**	**Parcel D**	**Parcel E**
Above-Groundwater Soils				
Metals with RWQCB soil values (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc)	All metals	All metals	All metals	All metals
Cyanide	Cyanide	Cyanide	Cyanide	Cyanide
PAHs	Total PAH	Total PAH	Total PAH	Total PAH
Pesticides	Total DDT	Heptachlor epoxide	Total chlordane, Total DDT	Total DDT
PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs
Pentachlorophenol (PCP)	None	None	None	PCP
Below-Groundwater Soils				
PAHs	Fluoranthene, total PAHs	Fluoranthene, total PAHs	Fluoranthene, total PAHs	Fluoranthene, total PAHs
Pesticides	Total DDT, total chlordane	Total DDT, total endrin, total endosulfan, heptachlor, heptachlor epoxide, 1,4-dichlorobenzene, total chlordane	Dieldrin, total endrin, endosulfan, heptachlor, heptachlor epoxide, total chlordane	Aldrin, total DDT, endosulfan, heptachlor, heptachlor epoxide, beta-BHC, 1,4-dichlorobenzene
PCBs	Total PCBs	Total PCBs	Total PCBs	None
Pentachlorophenol	PCP	None	None	PCP

TABLE 3-2

CHEMICALS EXCEEDING AMBIENT WATER QUALITY CRITERIA BY PARCEL

Contaminant	Parcel B	Parcel C	Parcel D	Parcel E
Metals	Arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc	Arsenic, cadmium, chromium, copper, lead, nickel	Arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc	Arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc
Cyanide	Cyanide	None	Cyanide	Cyanide
PAHs*	Phenanthrene	Phenanthrene	None	Phenanthrene
PCBs	Arochlor 1260	None	Arochlor 1260	Arochlor 1242, 1254, 1260
Pesticides	None	None	DDT, DDE, DDD, heptachlor, toxaphene	Heptachlor
PCP	None	None	None	PCP
Bis(2-ethylhexyl)phthalate	None	None	None	Bis(2-ethylhexyl)phthalate

* PAHs detected on site that do not have ambient water qualtiy criteria were retained as COPCs. These PAHs are as follows:

Parcel B: Anthracene, fluorene, phenanthrene, pyrene, acenaphthene, fluoranthene, naphthalene

Parcel C: No PAHs other than phenanthrene retained

Parcel D: Benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, pyrene, acenaphthene, fluoranthene

Parcel E: Anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene benzo(g,h,i)perylene, chrysene, fluorene, indeno(1,2,3-cd)pyrene, pyrene, acenaphthene, fluoranthene, naphthalene

TABLE 3-3

OFFSHORE CONTAMINANTS OF POTENTIAL CONCERN

Offshore Sediment	
• Antimony	• Manganese
• Arsenic	• Mercury
• Cadmium	• Nickel
• Chromium	• Silver
• Copper	• Vanadium
• Lead	• Zinc
• Tributyltin	
	• High-Molecular-Weight PAHs:
• Low-Molecular-Weight PAHs:	
	Chrysene
Naphthalene	Benzo(a)anthracene
Fluorene	Indeno(1,2,3-CD)pyrene
Anthracene	Benzo(b)fluoranthene
Phenanthrene	Dibenzo(a,h)anthracene
Acenaphthylene	Benzo(a)pyrene
Fluoranthene	
Pyrene	
Benzo(k)fluoranthene	
Acenaphthene	
Benzo(g,h,i)perylene	
1-methylnaphthalene	
• DDT	
• DDE	
• DDD	
• Dieldrin	
• Endrin	
• Chlordane (alpha and gamma)	
• PCBs	

TABLE 3-4

ESAP SURFACE SEDIMENT DATA SUMMARY

STATION	Total No. of Chemicals Detected	No. of Chemicals with Criteria	No. of Chemicals < ER-L	No. of Chemicals > ER-L and < ER-M	No. of Chemicals > ER-M	Hazard Index Based on ER-L	Hazard Index Based on ER-M
S-01	26	13	6	6	1	433.37	3.97
S-02	26	13	7	5	1	370.86	4.49
S-03	22	9	4	4	1	100.60	2.73
S-04	36	16	3	8	5	7,882.09	24.99
S-05	21	9	3	5	1	232.90	3.27
S-06	32	14	4	8	2	30.61	5.25
S-07	30	16	5	10	1	106.62	4.69
S-08	32	15	5	9	1	22.86	4.90
S-09	27	11	5	6	0	215.14	1.83
S-10	34	15	5	9	1	591.78	5.07
S-11	29	12	3	8	1	809.08	5.60
S-12	30	12	2	7	3	690.34	8.03
S-13	27	12	1	8	3	5,874.81	18.40
S-14	60	18	2	12	4	1,193.72	13.38
S-15	23	10	3	5	2	168.26	4.52
S-16	23	10	3	6	1	115.80	3.99
S-17	22	11	4	6	1	108.80	3.48
RS-1	28	13	4	7	3	135.33	7.55
RS-2	19	8	1	5	2	273.42	4.43
RS-3	17	7	3	2	2	17.68	4.36

TABLE 3-5

TABLE 3-5

ESAP SUBSURFACE SEDIMENT (2.5 FEET) DATA SUMMARY

STATION	Total No. of Chemicals Detected	No. of Chemicals with Criteria	No. of Chemicals < ER-L	No. of Chemicals > ER-L and < ER-M	No. of Chemicals > ER-M	Hazard Index Based on ER-L	Hazard Index Based on ER-M
S-01	30	12	3	7	2	857.99	5.64
S-02	28	10	3	6	1	163.39	3.32
S-03	24	11	3	7	1	423.02	4.47
S-04	37	16	1	9	6	14,278.28	25.51
S-05	26	10	2	7	1	288.40	3.89
S-06	27	9	4	4	1	241.50	3.38
S-07	32	15	5	9	1	145.60	4.60
S-08	32	13	5	7	1	206.69	4.00
S-09	24	9	1	7	1	1,232.46	5.13
S-10	25	8	3	4	1	124.88	2.45
S-11	22	7	2	4	1	9.01	2.62
S-12	32	12	1	10	1	499.22	6.07
S-13	39	15	1	6	8	5,424.74	25.66
S-14	34	16	2	12	2	1,077.00	7.59
S-15	31	13	4	7	2	646.28	10.50
S-16	30	12	2	7	3	728.32	7.21
S-17	26	10	2	6	2	218.09	4.78
RS-1	17	7	4	2	1	14.54	2.21
RS-2	22	9	2	5	2	225.71	5.02
RS-3	19	9	1	7	1	16.88	4.33

TABLE 3-6

SIGNIFICANT CHEMICALS CONTRIBUTING TO THE CONTAMINANT LOAD FOR SURFACE SEDIMENTS

Station	Chemical (Based on HI-L)	% of HI-L	Chemical (Based on HI-M)	% of HI-M
S-01	Dieldrin Endrin	71.53 25.38	Dieldrin Nickel	19.60 35.67
S-02	Dieldrin	95.33	Dieldrin Nickel Mercury	29.37 50.68 15.13
S-03	Endrin	89.46	Mercury Nickel	13.41 51.95
S-04	Endrin Dieldrin	63.43 35.52	Dieldrin Mercury	28.01 31.56
S-05	Endrin	94.46	Mercury Nickel	14.64 49.30
S-06	4,4'-DDT Mercury Nickel	26.88 23.96 11.38	Nickel Mercury	26.90 29.54
S-07	Endrin	79.72	Nickel	26.67
S-08	Phenanthrene Nickel Pyrene Benzo(a)Anthracene	12.03 15.32 9.87 8.88	Pyrene Benzo(a)Anthracene	28.97 11.97
S-09	Endrin Dieldrin	39.83 58.29	Dieldrin Nickel	29.68 36.73
S-10	Endrin Dieldrin	38.02 58.30	Mercury Dieldrin Nickel	10.28 17.01 31.65
S-11	Endrin Dieldrin	52.84 44.76	Dieldrin Mercury Nickel	24.73 25.93 53.79
S-12	Dieldrin	94.16	Mercury 4,4'-DDD Dieldrin Nickel	10.88 13.08 20.24 24.86
S-13	Endrin Dieldrin	34.04 64.68	Dieldrin	51.62
S-14	Endrin Dieldrin	46.07 41.89	Silver Nickel Fluorene	10.70 12.95 23.52
S-15	Endrin	89.15	Mercury Lead Nickel	10.91 27.50 35.07

TABLE 3-6

SIGNIFICANT CHEMICALS CONTRIBUTING TO THE CONTAMINANT LOAD FOR SURFACE SEDIMENTS
(Continued)

Station	Chemical (Based on HI-L)	% of HI-L	Chemical (Based on HI-M)	% of HI-M
S-16	Endrin	86.35	Lead Nickel	19.77 40.88
S-17	Endrin	82.72	Mercury Nickel	14.57 46.60
RS-1	Endrin	73.89	Pyrene Benzo(a)Pyrene Nickel	17.33 17.39 18.51
RS-2	Endrin	93.26	Lead Nickel	33.75 40.28
RS-3	Mercury Nickel Lead	18.10 20.11 38.28	Mercury Nickel Lead	15.51 33.03 33.25
IR01	Fluorene Acenaphthlene Anthracene Lead	17.49 21.06 19.15 12.51	Anthracene Lead	14.55 26.25
IR02	4,4'-DDE 4,4'-DDT 4,4'-DDD Silver	11.99 32.35 17.04 11.27	Nickel 4,4'-DDD Silver Lead	12.34 13.13 23.47 16.00
IR03	Nickel Silver	14.68 48.99	Nickel Silver	23.05 51.31
IR07	Lead Nickel	11.62 50.27	Nickel	67.42

Notes:

HI-L = Hazard index based on ER-L
HI-M = Hazard index based on ER-M
% of HI-L = Percent that chemical hazard quotient contributes to HI-L.
% of HI-M = Percent that chemical hazard quotient contributes to HI-M.

TABLE 3-7

SIGNIFICANT CHEMICALS CONTRIBUTING TO THE CONTAMINANT LOAD FOR SUBSURFACE SEDIMENTS (2.5 FEET)

Station	Chemical (Based on HI-L)	% of HI-L	Chemical (Based on HI-M)	% of HI-M
S-01	Dieldrin Endrin	69.93 27.97	Dieldrin Nickel	26.58 33.13
S-02	Endrin	91.80	Nickel Mercury	51.49 11.87
S-03	Endrin	94.56	4,4'-DDD Nickel	21.23 34.44
S-04	Endrin Dieldrin	80.54 19.19	Endrin Dieldrin Copper Nickel	20.04 26.46 12.84 10.08
S-15	Endrin Dieldrin	48.74 34.33	Mercury Lead Nickel	14.85 23.86 27.41
S-16	Endrin Dieldrin	61.10 34.33	Mercury Nickel	45.61 17.32
S-17	Endrin	89.41	Lead Nickel	26.69 33.46
S-05	Endrin	93.62	Zinc Mercury Nickel	10.39 51.20 12.93
S-06	Endrin	95.24	Zinc Nickel Mercury	10.33 51.20 12.93
S-07	Endrin	82.42	Lead Nickel	13.65 29.63
S-08	Endrin	89.51	Nickel	41.23
S-09	Endrin	97.37	Lead Mercury 4-4'-DDT Nickel Endrin	10.37 11.25 11.83 35.95 10.39
S-10	Endrin	92.09	Mercury Nickel	18.43 49.37

TABLE 3-7

SIGNIFICANT CHEMICALS CONTRIBUTING TO THE CONTAMINANT LOAD FOR SUBSURFACE SEDIMENTS (2.5 FEET) (Continued)

Station	Chemical (Based on HI-L)	% of HI-L	Chemical (Based on HI-M)	% of HI-M
S-11	Nickel Mercury Chromium Copper	46.19 12.57 11.51 13.25	Nickel	64.30
S-12	Dieldrin Endrin	55.09 40.06	Mercury Dieldrin Nickel	14.85 11.33 33.20
S-13	Endrin Dieldrin	35.95 61.75	4,4'-DDE Dieldrin	23.09 32.63
S-14	Endrin Dieldrin	36.21 60.35	Dieldrin Mercury Nickel	21.42 10.40 23.28
RS-1	4,4'-DDT Nickel	52.23 20.10	Mercury 4,4'-DDT Nickel	11.46 11.77 53.54
RS-2	Endrin Dieldrin	48.73 42.09	Lead Nickel	34.66 31.10
RS-3	Copper Mercury Nickel Pyrene	12.68 14.61 26.05 10.69	Mercury Nickel Pyrene	12.03 41.12 10.66

Notes:

HI-L = Hazard index based on ER-L
HI-M = Hazard index based on ER-M
% of HI-L = Percent that chemical hazard quotient contributes to HI-L.
% of HI-M = Percent that chemical hazard quotient contributes to HI-M.

TABLE 4-1

ASSESSMENT ENDPOINT SELECTION CRITERIA SUMMARY

Assessment Endpoint Protection of populations or individuals of the following organisms	Assessment Endpoint Selection Criteria													
	Observed at HPA	High Potential for Exposure Based on Feeding Behavior	High Potential for Exposure Based on Amount and Type of Site Use	Small Home Range Relative to Site	Susceptible to Contaminant Effects	Toxicological Literature Available	Susceptible to Effects of Bioaccumulation	Important to Structure and Function of Ecological Community	Species of Special Conservation Concern	High Trophic Level Predator	Important Prey Species	High Social and Recreational Value	Economically Important	Directly Measured
Peregrine falcon (*Falco peregrinus*)	✓	✓			✓		✓		✓	✓		✓		
American kestrel (*Falco spaverius*)	✓	✓	✓	✓	✓	✓	✓			✓		✓		
California brown pelican (*Pelecanus occidentalis*)	✓	✓			✓	✓	✓		✓	✓		✓		
Double-crested cormorant (*Phalocrocorax auritus*)	✓	✓			✓		✓		✓	✓				
Great blue heron (*Ardea herodius*) or other wader	✓	✓	✓	✓	✓		✓		✓	✓		✓		
Willet (*Catoptrophorus semipalmatus*)	✓	✓	✓	✓	✓		✓	✓			✓	✓		
Benthic invertebrate community	✓	✓	✓	✓	‡	✓		✓	‡		✓		✓	✓
Native goby species	✓	✓	✓	✓	‡	✓		✓	‡		✓			✓

✓ = Yes
‡ = Yes, but may differ among species in the group

Natural history information appears in the HPA species lists.

TABLE 4-2

DIET, HOME RANGE, AND MEASUREMENT ENDPOINT SELECTION FOR AQUATIC AVIAN ASSESSMENT ENDPOINTS

Assessment Endpoint *Protection of HPA populations and individuals of the following organisms*	**Diet** *Ingestion of contaminated prey and prey-associated soil or sediment as a critical exposure pathway*	**Site Use as Indicated by Home Range** *Distance travelled from nest or roost to forage or "home range area"*	**Potential Measurement Endpoint**	**Rationale for Measurement Endpoint Selection**
Peregrine falcon (*Falco peregrinus*)	Birds (often) Mammals, fish, insects (rarely)[a] Birds: Doves, pigeons, shorebirds, waterfowl, passerines[c]	Nests averaged 5.3 km from nearest foraging marsh and 12.2 km from nearest marsh over 130 acre[b]. Home range included area encompassed by a radius up to 23 km from cliff nests[d]. Home range was approximately 320 km^2, and size fluctuated with prey availability[e].	Measurement of concentration of contaminants in one or more of the following organisms: · Aquatic invertebrates crustaceans, amphipods, isopods, decapods, mollusks, polychaetes Bioassays conducted on the following organisms: · *Euhaustorius estuarius* · *Strongylocentrotus purpuratus* Possible qualitative evaluation due to the size of the home range relative to that of HPA and the lack of a suitable tissue residue measurement organism for direct measurement of exposure through prey ingestion	· Measurement of the health of the shorebirds' prey base, as an indirect link to the falcon · Measurement of the health of the shorebirds' prey base, as an indirect link to the falcon

TABLE 4-2

DIET, HOME RANGE, AND MEASUREMENT ENDPOINT SELECTION FOR AQUATIC AVIAN ASSESSMENT ENDPOINTS (Continued)

Assessment Endpoint	Diet	Site Use as Indicated by Home Range	Potential Measurement Endpoint	Rationale for Measurement Endpoint Selection
California brown pelican (*Pelecanus occidentalis californicus*)	Fish (mainly) Crustaceans, carrion (occasionally)[a] ——— Anchovies (in the breeding season)[c]	Birds were most numerous within 20 km of nesting islands[a].	Measurement of concentration of contaminants in the following organism: • Fish: Arrow goby (*Clevelandia ios*), sanddab (*Citharichthys stignaeous*) Possible qualitative evaluation due to home range constraints and lack of a tissue residue measurement organism reflective of HPA contamination	• Measurement of the contaminant concentration in these fish as representing food of pelican
Double-crested cormorant (*Phalacrocorax auritus*)	Fish Crustaceans and amphibians (occasionally)[a] ——— Schooling fish (primarily) Other small vertebrates (rarely)[c] ——— Fish: Sculpins, smelt, river and bay perch, catfish, flounder, suckers, carp Rarely crustaceans and amphibians[g]	Forages within 8 to 16 km of roost or nest colony[f].	Measurement of concentration of contaminants in one or more of the following organisms: • Fish: Arrow goby (*Clevelandia ios*), sanddab (*Citharichthys stignaeous*) Possible qualitative evaluation due lack of a tissue residue measurement organism reflective of contamination at HPA	• Measurement of the contaminant concentration in these fish as representing the food of cormorant

TABLE 4-2

DIET, HOME RANGE, AND MEASUREMENT ENDPOINT SELECTION FOR AQUATIC AVIAN ASSESSMENT ENDPOINTS (Continued)

Assessment Endpoint	Diet	Site Use as Indicated by Home Range	Potential Measurement Endpoint	Rationale for Measurement Endpoint Selection
Great blue heron (*Ardea herodius*)	Fish: Staghorn sculpin (*Leptocottus armatus*) (37.6%) Starry flounder (*Platychthys stellatus*) (28.3%) Other, including shiner sea perch and penpoint gunnel (34.1%)[h]	Birds flew up to 16 km from nest[i].	Measurement of concentration of contaminants in one or more of the following organisms: • Fish: Arrow goby (*Clevelandia ios*), sanddab (*Citharichthys stignaeous*) Bioassays conducted on the following organisms: • *Euhaustorius estuarius* • *Strongylocentrotus purpuratus*	• Measurement of the contaminant concentration in food of heron • Measurement of the health of the heron's prey base, as an indirect link to the heron
Willet (*Catoptrophorus semipalmatus*)	Small crustaceans and mollusks (mainly)[a] ——— Fish Polychaete worms Larval and pupal dipteran insects[j]	Distance from roosts to intertidal feeding areas may be as little as 1000 m or several miles[k].	Measurement of concentration of contaminants in one or more of the following organisms: • Aquatic invertebrates: crustaceans, amphipods, isopods, decapods, mollusks, polychaetes Bioassays on one or more of the following invertebrates: • *Euhaustorius estuarius* • *Strongylocentrotus purpuratus*	• Measurement of the contaminant concentration in food of willet • Measurement of the health of the willet's prey base, as an indirect link to the willet

TABLE 4-2

DIET, HOME RANGE, AND MEASUREMENT ENDPOINT SELECTION FOR AQUATIC AVIAN ASSESSMENT ENDPOINTS (Continued)

Notes:

a California Department of Fish and Game (CDFG) 1990.

b Porter and White 1973, as cited in CDFG 1990. Study conducted in Utah.

c Ehrlich, Dobkin, and Wheye 1988.

d CDFG 1990. Study conducted in Rocky Mountains.

e CDFG 1990. Study conducted in Sonoma County, California.

f Palmer 1962, as cited in CDFG 1990.

g Cogswell 1977.

h Krebs 1974, as cited in EPA 1993. Study was conducted on a coastal island in British Columbia, Canada. Percentages reflect fish species caught by herons based on observations. 73.4% prey were less than 1/3 the beak size; 19.2% prey were about 1/2 beak length; 7.4% prey were greater than beak length.

i Krebs 1974, as cited in CDFG 1990. Study conducted in British Columbia in Canada.

j Stenzel and others 1976, as cited in CDFG 1990. Study conducted in Bolinas Lagoon in California.

k Kelly and Cogswell 1979, as cited in CDFG 1990.

TABLE 7-1

COMPARISON OF AMPHIPOD SOLID-PHASE BIOASSAY TESTS

Organism	Habitat	Salinity Tolerance	Sediment Tolerance	Sensitivity to Contaminants	General Comments
Rhepoxynius abronius	Free burrowing	>25ppt[a]	Less tolerant of fine sediments.[b]	Highly sensitive[c,d]	Sensitive to high TOC[e] and grain size.
Ampelisca abdita	Tube dweller	10 - 35ppt[a]	Sediments from fine sand to mud and silt without shell.[f] May be sensitive to coarse-grained sediments.	Less sensitive[c] than *E. estuarius*	Abundant in sediments of high organic content. Introduced species.
Eohaustorius estuarius	Free burrowing	2 - 28ppt[a]	Tolerant of fine sediments.[b] Lives in sandy sediments.	Less sensitive[c] than *R. abronius*	Less sensitive to grain size.
Grandidierella japonica	Infaunal tube dweller	30 - 35ppt[a]	Lives in a variety of sediment types[f]	Less sensitive than *R. abronius*	Introduced species.[f]

a MacDonald and others 1992.
b Dewitt, Swartz, and Lamberson 1989.
c PRC 1994c.
d Long and Buchman 1989.
e Long and others 1990.
f American Society for Testing Materials 1991.

TABLE 7-2

LEVEL OF SIGNIFICANCE FOR INTERPRETING TOXICITY TEST RESULTS

	Mean Survival < 80% of Reference Mean	**Mean Survival > 80% of Reference Mean**
Statistically Different from Control	Sample Toxic	Sample Nontoxic
Not Statistically Different from Control	Sample Toxic	Sample Nontoxic

TABLE 9-1

DIET, HOME RANGE, AND MEASUREMENT ENDPOINT SELECTION FOR AMERICAN KESTREL FOR POTENTIAL FUTURE INVESTIGATIONS

Assessment Endpoint *Protection of HPA populations and individuals of the following organisms*	**Diet** *Ingestion of contaminated prey and prey-associated soil or sediment as a critical exposure pathway*	**Site Use as Indicated by Home Range** *Distance travelled from nest or roost to forage or "home range area"*	**Potential Measurement Endpoint**	**Rationale for Measurement Endpoint Selection**
American kestrel (*Falco spaverius*)	Invertebrates: Coleoptera (beetles) (10.75%) Other (14.15%) Herpetofauna: Frog (*Rana aurora*) (7.95%) Other (12.20%) Mammals: California vole (*Microtus californicus*) (30.15%) Vagrant shrew (*Sorex vagrans*) (9.35%) Other (11.45%)[a] Invertebrates: Coleoptera (beetles) (17.4%) Lumbricidae (earthworms) (7.1%) Orthoptera (grasshoppers) (1.0%) Lepidoptera (butterflies) (0.5%) Unidentified (10.9%) Herpetofauna: Frog (*Rana aurora*) (10.2%) Pacific tree frog (*Hyla regilla*) (9.2%) Snakes (4.1%) Birds: Fringillidae (2.9%) Mammals: California vole (*Microtus californicus*) (26.5%) Western harvest mouse (*Reithrodontmys megalotis*) (1.9%) Vagrant shrew (*Sorex vagrans*) (8.5%)[b]	Home ranges varied from 154 to 452 ha[c].	Measurement of concentration of contaminants in one or more of the following organisms: · Small mammals: California vole (*Microtus californicus*) · Terrestrial invertebrates: large insects such as grasshoppers, crickets, and beetles	· Measurement of the contaminant concentration in food of kestrel

TABLE 9-1

DIET, HOME RANGE, AND MEASUREMENT ENDPOINT SELECTION FOR AMERICAN KESTREL FOR POTENTIAL FUTURE INVESTIGATIONS (Continued)

Assessment Endpoint	Diet	Site Use as Indicated by Home Range	Potential Measurement Endpoint	Rationale for Measurement Endpoint Selection
American kestrel (*Falco spaverius*) (Continued)	Invertebrates (32.6%) Reptiles (1.9%) Birds (30.3%) Mammals (31.7%) Other (3.5%)[d]			

Notes:

a CDFG 1990. Study conducted in Sonoma County, California.

b Porter and White 1973, as cited in CDFG 1990. Study conducted in Utah.

c Enderson 1960 and Mills 1976, as cited in CDFG 1990. Study consisted of winter home ranges.

d Meyer and Balgooyen 1987, as cited in EPA 1993. Study was conducted during winter in open areas and woods in California. Percentages reflect percent of wet weight of prey captured.

APPENDIX A

ESAP CHEMICAL DATA TABLES

ESAP STATIONS - PARCEL B SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-01	Aluminum	18900	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Barium	48.6	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Calcium	4340	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Cobalt	19.2	mg/kg	Parcel B	---	---	---	---	---	---
S-01	delta-BHC	2.4	ug/kg	Parcel B	---	---	---	---	---	---
S-01	Dibutyltin	14	ug/kg	Parcel B	---	---	---	---	---	---
S-01	Iron	32400	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Magnesium	11800	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Manganese	483	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Potassium	3330	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Sodium	13500	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Tributyltin	71	ug/kg	Parcel B	---	---	---	---	---	---
S-01	Vanadium	53.8	mg/kg	Parcel B	---	---	---	---	---	---
S-01	Endrin	2.2	ug/kg	Parcel B	0.02	45.00	110.00	0.05	25.38%	1.24%
S-01	Arsenic	5.6	mg/kg	Parcel B	8.20	70.00	0.68	0.08	0.16%	2.02%
S-01	4,4'-DDE	2.4	ug/kg	Parcel B	2.20	27.00	1.09	0.09	0.25%	2.25%
S-01	Fluoranthene	510	ug/kg	Parcel B	600.00	5100.00	0.85	0.10	0.20%	2.53%
S-01	Lead	23.6	mg/kg	Parcel B	46.70	218.00	0.51	0.11	0.12%	2.74%
S-01	4,4'-DDD	2.3	ug/kg	Parcel B	2.00	20.00	1.15	0.12	0.27%	2.91%
S-01	Copper	45.9	mg/kg	Parcel B	34.00	270.00	1.35	0.17	0.31%	4.30%
S-01	Chromium	74	mg/kg	Parcel B	81.00	370.00	0.91	0.20	0.21%	5.06%
S-01	Pyrene	600	ug/kg	Parcel B	665.00	2600.00	0.90	0.23	0.21%	5.84%
S-01	Zinc	107	mg/kg	Parcel B	150.00	410.00	0.71	0.26	0.16%	6.60%
S-01	Mercury	0.26	mg/kg	Parcel B	0.15	0.71	1.73	0.37	0.40%	9.26%
S-01	Dieldrin	6.2	ug/kg	Parcel B	0.02	8.00	310.00	0.78	71.53%	19.60%
S-01	Nickel	72.8	mg/kg	Parcel B	20.90	51.60	3.48	1.41	0.80%	35.67%
	HAZARD INDEX						433.37	3.95		

ESAP STATIONS - PARCEL B SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-02	Aluminum	22100	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Barium	57	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Calcium	5010	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Cobalt	11.3	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Dibutyltin	10	ug/kg	Parcel B	---	---	---	---	---	---
S-02	gamma-Chlordane	0.75	ug/kg	Parcel B	---	---	---	---	---	---
S-02	Iron	33400	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Magnesium	12300	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Manganese	488	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Potassium	3610	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Sodium	13800	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Tributyltin	54	ug/kg	Parcel B	---	---	---	---	---	---
S-02	Vanadium	57.7	mg/kg	Parcel B	---	---	---	---	---	---
S-02	Arsenic	3.6	mg/kg	Parcel B	8.20	70.00	0.44	0.05	0.12%	1.73%
S-02	Fluoranthene	440	ug/kg	Parcel B	600.00	5100.00	0.73	0.09	0.20%	2.90%
S-02	Lead	20.6	mg/kg	Parcel B	46.70	218.00	0.44	0.09	0.12%	3.17%
S-02	4,4'-DDE	3.7	ug/kg	Parcel B	2.20	27.00	1.68	0.14	0.46%	4.60%
S-02	Copper	44.6	mg/kg	Parcel B	34.00	270.00	1.31	0.17	0.36%	5.55%
S-02	4,4'-DDT	9	ug/kg	Parcel B	1.58	46.10	5.70	0.20	1.55%	6.55%
S-02	Chromium	77.3	mg/kg	Parcel B	81.00	370.00	0.95	0.21	0.26%	7.01%
S-02	4,4'-DDD	4.2	ug/kg	Parcel B	2.00	20.00	2.10	0.21	0.57%	7.05%
S-02	Pyrene	570	ug/kg	Parcel B	665.00	2600.00	0.86	0.22	0.23%	7.36%
S-02	Zinc	117	mg/kg	Parcel B	150.00	410.00	0.78	0.29	0.21%	9.58%
S-02	Mercury	0.32	mg/kg	Parcel B	0.15	0.71	2.13	0.45	0.58%	15.13%
S-02	Dieldrin	7	ug/kg	Parcel B	0.02	8.00	350.00	0.88	95.33%	29.37%
S-02	Nickel	77.9	mg/kg	Parcel B	20.90	51.60	3.73	1.51	1.02%	50.68%
	HAZARD INDEX						367.13	2.98		

ESAP STATIONS - PARCEL B SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-03	Aluminum	19400	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Aroclor-1260	15	ug/kg	Parcel B	---	---	---	---	---	---
S-03	Barium	50	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Calcium	4490	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Cobalt	14.3	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Dibutyltin	13	ug/kg	Parcel B	---	---	---	---	---	---
S-03	Iron	30900	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Magnesium	11300	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Manganese	465	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Potassium	3490	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Sodium	14000	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Tributyltin	73	ug/kg	Parcel B	---	---	---	---	---	---
S-03	Vanadium	50.4	mg/kg	Parcel B	---	---	---	---	---	---
S-03	Endrin	1.8	ug/kg	Parcel B	0.02	45.00	90.00	0.04	89.46%	1.46%
S-03	4,4'-DDE	2.6	ug/kg	Parcel B	2.20	27.00	1.18	0.10	1.17%	3.53%
S-03	Arsenic	7.2	mg/kg	Parcel B	8.20	70.00	0.88	0.10	0.87%	3.77%
S-03	Lead	23.1	mg/kg	Parcel B	46.70	218.00	0.49	0.11	0.49%	3.88%
S-03	Copper	42.1	mg/kg	Parcel B	34.00	270.00	1.24	0.16	1.23%	5.71%
S-03	Chromium	71.7	mg/kg	Parcel B	81.00	370.00	0.89	0.19	0.88%	7.10%
S-03	Zinc	103	mg/kg	Parcel B	150.00	410.00	0.69	0.25	0.68%	9.20%
S-03	Mercury	0.26	mg/kg	Parcel B	0.15	0.71	1.73	0.37	1.72%	13.41%
S-03	Nickel	73.2	mg/kg	Parcel B	20.90	51.60	3.50	1.42	3.48%	51.95%
	HAZARD INDEX						100.60	2.73		

ESAP STATIONS - PARCEL B SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-04	Aldrin	22	ug/kg	Parcel B	---	---	---	---	---	---
S-04	alpha-Chlordane	68	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Aluminum	18200	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Aroclor-1260	2400	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Barium	85.6	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Benzo(b)fluoranthene	490	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Benzo(g,h,i)perylene	410	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Benzo(k)fluoranthene	550	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Bis(2-ethylhexyl)phthalate	700	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Copper	851	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Dibutyltin	250	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Indeno(1,2,3-cd)pyrene	360	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Iron	33900	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Magnesium	16600	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Manganese	422	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Monobutyltin	10	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Potassium	3190	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Sodium	11300	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Tributyltin	1100	ug/kg	Parcel B	---	---	---	---	---	---
S-04	Vanadium	54.9	mg/kg	Parcel B	---	---	---	---	---	---
S-04	Chromium	133	mg/kg	Parcel B	400.00	2800.00	0.33	0.05	0.00%	0.19%
S-04	Copper	20.8	mg/kg	Parcel B	34.00	270.00	0.61	0.08	0.01%	0.31%
S-04	Chrysene	460	ug/kg	Parcel B	400.00	2800.00	1.15	0.16	0.01%	0.66%
S-04	Fluoranthene	920	ug/kg	Parcel B	600.00	5100.00	1.53	0.18	0.02%	0.72%
S-04	Benzo(a)pyrene	340	ug/kg	Parcel B	430.00	1600.00	0.79	0.21	0.01%	0.85%
S-04	Benzo(a)anthracene	340	ug/kg	Parcel B	261.00	1600.00	1.30	0.21	0.02%	0.85%
S-04	Phenanthrene	650	ug/kg	Parcel B	240.00	1500.00	2.71	0.43	0.03%	1.73%
S-04	Pyrene	1200	ug/kg	Parcel B	665.00	2600.00	1.80	0.46	0.02%	1.85%
S-04	Zinc	267	mg/kg	Parcel B	150.00	410.00	1.78	0.65	0.02%	2.61%
S-04	Lead	157	mg/kg	Parcel B	46.70	218.00	3.36	0.72	0.04%	2.88%
S-04	Arsenic	65.4	mg/kg	Parcel B	8.20	70.00	7.98	0.93	0.10%	3.74%
S-04	4,4'-DDD	32	ug/kg	Parcel B	2.00	20.00	16.00	1.60	0.20%	6.40%
S-04	Nickel	113	mg/kg	Parcel B	20.90	51.60	5.41	2.19	0.07%	8.76%
S-04	Endrin	100	ug/kg	Parcel B	0.02	45.00	5000.00	2.22	63.43%	8.89%
S-04	Dieldrin	56	ug/kg	Parcel B	0.02	8.00	2800.00	7.00	35.52%	28.01%
S-04	Mercury	5.6	mg/kg	Parcel B	0.15	0.71	37.33	7.89	0.47%	31.56%
	HAZARD INDEX						7882.09	24.99		

ESAP STATIONS - PARCEL B 2.5 FEET SAMPLES

Station	Chemical	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-01	Acetone	160	ug/kg	---	---	---	---	---	---
S-01	Aluminum	26300	mg/kg	---	---	---	---	---	---
S-01	Barium	60.3	mg/kg	---	---	---	---	---	---
S-01	Calcium	4930	mg/kg	---	---	---	---	---	---
S-01	Carbon disulfide	7	ug/kg	---	---	---	---	---	---
S-01	Cobalt	26.8	mg/kg	---	---	---	---	---	---
S-01	delta-BHC	34	ug/kg	---	---	---	---	---	---
S-01	Dibutyltin	13	ug/kg	---	---	---	---	---	---
S-01	gamma-Chlordane	2.3	ug/kg	---	---	---	---	---	---
S-01	Iron	39400	mg/kg	---	---	---	---	---	---
S-01	Magnesium	14000	mg/kg	---	---	---	---	---	---
S-01	Manganese	435	mg/kg	---	---	---	---	---	---
S-01	Methylene chloride	15	mg/kg	---	---	---	---	---	---
S-01	Potassium	4630	mg/kg	---	---	---	---	---	---
S-01	Sodium	14700	mg/kg	---	---	---	---	---	---
S-01	Toluene	10	mg/kg	---	---	---	---	---	---
S-01	Tributyltin	44	ug/kg	---	---	---	---	---	---
S-01	Vanadium	67	mg/kg	---	---	---	---	---	---
S-01	Arsenic	4.6	mg/kg	8.2	70	0.56	0.07	0.07%	1.16%
S-01	Endrin	4.8	ug/kg	0.02	45	240.00	0.11	27.97%	1.89%
S-01	Lead	27.2	mg/kg	46.7	218	0.58	0.12	0.07%	2.21%
S-01	Copper	58.2	mg/kg	34	270	1.71	0.22	0.20%	3.82%
S-01	4,4'-DDE	6	ug/kg	2.2	27	2.73	0.22	0.32%	3.94%
S-01	Chromium	93.5	mg/kg	81	370	1.15	0.25	0.13%	4.48%
S-01	Pyrene	680	ug/kg	665	2600	1.02	0.26	0.12%	4.63%
S-01	4,4'-DDD	5.5	ug/kg	2	20	2.75	0.28	0.32%	4.87%
S-01	Zinc	140	mg/kg	150	410	0.93	0.34	0.11%	6.05%
S-01	Mercury	0.29	mg/kg	0.15	0.71	1.93	0.41	0.23%	7.24%
S-01	Dieldrin	12	ug/kg	0.02	8	600.00	1.50	69.93%	26.58%
S-01	Nickel	96.5	mg/kg	20.9	51.6	4.62	1.87	0.54%	33.13%
	HAZARD INDEX					857.99	5.64		

ESAP STATIONS - PARCEL B 2.5 FEET SAMPLES

Station	Chemical	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-02	Acetone	160	ug/kg	---	---	---	---	---	---
S-02	Aluminum	23900	mg/kg	---	---	---	---	---	---
S-02	Barium	55	mg/kg	---	---	---	---	---	---
S-02	Calcium	4550	mg/kg	---	---	---	---	---	---
S-02	Cobalt	14.3	mg/kg	---	---	---	---	---	---
S-02	Dibutyltin	9	ug/kg	---	---	---	---	---	---
S-02	Endrin ketone	14	mg/kg	---	---	---	---	---	---
S-02	gamma-Chlordane	4.7	ug/kg	---	---	---	---	---	---
S-02	Iron	36200	mg/kg	---	---	---	---	---	---
S-02	Magnesium	13000	mg/kg	---	---	---	---	---	---
S-02	Manganese	487	mg/kg	---	---	---	---	---	---
S-02	Methyl ethyl ketone	56	ug/kg	---	---	---	---	---	---
S-02	Methylene chloride	9	ug/kg	---	---	---	---	---	---
S-02	Potassium	4140	mg/kg	---	---	---	---	---	---
S-02	Sodium	14500	mg/kg	---	---	---	---	---	---
S-02	Toluene	8	ug/kg	---	---	---	---	---	---
S-02	Tributyltin	32	ug/kg	---	---	---	---	---	---
S-02	Vanadium	59.8	mg/kg	---	---	---	---	---	---
S-02	Arsenic	4.4	mg/kg	8.2	70	0.54	0.06	0.33%	1.89%
S-02	Endrin	3	ug/kg	0.02	45	150.00	0.07	91.80%	2.01%
S-02	Lead	24.2	mg/kg	46.7	218	0.52	0.11	0.32%	3.34%
S-02	4,4'-DDD	2.5	ug/kg	2	20	1.25	0.13	0.77%	3.76%
S-02	4,4'-DDE	3.5	ug/kg	2.2	27	1.59	0.13	0.97%	3.90%
S-02	Copper	52.1	mg/kg	34	270	1.53	0.19	0.94%	5.81%
S-02	Chromium	85.9	mg/kg	81	370	1.06	0.23	0.65%	6.99%
S-02	Zinc	122	mg/kg	150	410	0.81	0.30	0.50%	8.95%
S-02	Mercury	0.28	mg/kg	0.15	0.71	1.87	0.39	1.14%	11.87%
S-02	Nickel	88.3	mg/kg	20.9	51.6	4.22	1.71	2.59%	51.49%
	HAZARD INDEX					163.39	3.32		

ESAP STATIONS - PARCEL B 2.5 FEET SAMPLES

Station	Chemical	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-03	Aluminum	22600	mg/kg	---	---	---	---	---	---
S-03	Barium	54	mg/kg	---	---	---	---	---	---
S-03	Calcium	4860	mg/kg	---	---	---	---	---	---
S-03	Cobalt	21.6	mg/kg	---	---	---	---	---	---
S-03	Dibutyltin	13	ug/kg	---	---	---	---	---	---
S-03	Iron	35100	mg/kg	---	---	---	---	---	---
S-03	Magnesium	12700	mg/kg	---	---	---	---	---	---
S-03	Manganese	439	mg/kg	---	---	---	---	---	---
S-03	Potassium	3810	mg/kg	---	---	---	---	---	---
S-03	Sodium	15400	mg/kg	---	---	---	---	---	---
S-03	Toluene	21	mg/kg	---	---	---	---	---	---
S-03	Tributyltin	40	ug/kg	---	---	---	---	---	---
S-03	Vanadium	61.2	mg/kg	---	---	---	---	---	---
S-03	Arsenic	3.3	mg/kg	8.2	70	0.40	0.05	0.10%	1.05%
S-03	Lead	23.2	mg/kg	46.7	218	0.50	0.11	0.12%	2.38%
S-03	Endrin	8	ug/kg	0.02	45	400.00	0.18	94.56%	3.97%
S-03	4,4'-DDE	4.9	ug/kg	2.2	27	2.23	0.18	0.53%	4.06%
S-03	Copper	53.7	mg/kg	34	270	1.58	0.20	0.37%	4.45%
S-03	Chromium	83.9	mg/kg	81	370	1.04	0.23	0.24%	5.07%
S-03	Pyrene	610	ug/kg	665	2600	0.92	0.23	0.22%	5.24%
S-03	Zinc	159	mg/kg	150	410	1.06	0.39	0.25%	8.67%
S-03	Mercury	0.3	mg/kg	0.15	0.71	2.00	0.42	0.47%	9.44%
S-03	4,4'-DDD	19	ug/kg	2	20	9.50	0.95	2.25%	21.23%
S-03	Nickel	79.5	mg/kg	20.9	51.6	3.80	1.54	0.90%	34.44%
	HAZARD INDEX					423.02	4.47		

ESAP STATIONS - PARCEL B 2.5 FEET SAMPLES

Station	Chemical	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-04	Acetone	35	ug/kg	---	---	---	---	---	---
S-04	alpha-Chlordane	110	ug/kg	---	---	---	---	---	---
S-04	Aluminum	20500	mg/kg	---	---	---	---	---	---
S-04	Aroclor-1260	7400	mg/kg	---	---	---	---	---	---
S-04	Barium	71.3	mg/kg	---	---	---	---	---	---
S-04	Benzo(b)fluoranthene	620	ug/kg	---	---	---	---	---	---
S-04	Benzo(g,h,i)perylene	960	ug/kg	---	---	---	---	---	---
S-04	Benzo(k)fluoranthene	690	ug/kg	---	---	---	---	---	---
S-04	Beryllium	0.99	mg/kg	---	---	---	---	---	---
S-04	Calcium	6730	mg/kg	---	---	---	---	---	---
S-04	Cobalt	24.2	mg/kg	---	---	---	---	---	---
S-04	Dibutyltin	30	ug/kg	---	---	---	---	---	---
S-04	Endosulfan I	230	ug/kg	---	---	---	---	---	---
S-04	gamma-Chlordane	9.5	ug/kg	---	---	---	---	---	---
S-04	Iron	36200	mg/kg	---	---	---	---	---	---
S-04	Magnesium	22600	mg/kg	---	---	---	---	---	---
S-04	Manganese	436	mg/kg	---	---	---	---	---	---
S-04	Potassium	3720	mg/kg	---	---	---	---	---	---
S-04	Sodium	9980	mg/kg	---	---	---	---	---	---
S-04	Tributyltin	130	ug/kg	---	---	---	---	---	---
S-04	Vanadium	66.3	mg/kg	---	---	---	---	---	---
S-04	Arsenic	5.7	mg/kg	8.2	70	0.70	0.08	0.000049	0.32%
S-04	Chrysene	550	ug/kg	400	2800	1.38	0.20	0.000096	0.77%
S-04	Fluoranthene	1100	ug/kg	600	5100	1.83	0.22	0.000128	0.85%
S-04	Benzo(a)anthracene	430	ug/kg	261	1600	1.65	0.27	0.000115	1.05%
S-04	Chromium	133	mg/kg	81	370	1.64	0.36	0.000115	1.41%
S-04	Phenanthrene	570	ug/kg	240	1500	2.38	0.38	0.000166	1.49%
S-04	Lead	95.7	mg/kg	46.7	218	2.05	0.44	0.000144	1.72%
S-04	Benzo(a)pyrene	730	ug/kg	430	1600	1.70	0.46	0.000119	1.79%
S-04	Zinc	207	mg/kg	150	410	1.38	0.50	0.000097	1.98%
S-04	Pyrene	1500	ug/kg	665	2600	2.26	0.58	0.000158	2.26%
S-04	Mercury	1.4	mg/kg	0.15	0.71	9.33	1.97	0.000654	7.73%
S-04	4,4'-DDD	47	ug/kg	2	20	23.50	2.35	0.001646	9.21%
S-04	Copper	694	mg/kg	34	270	20.41	2.57	0.00143	10.08%
S-04	Nickel	169	mg/kg	20.9	51.6	8.09	3.28	0.000566	12.84%
S-04	Endrin	230	ug/kg	0.02	45	11500.00	5.11	0.805419	20.04%
S-04	Dieldrin	54	ug/kg	0.02	8	2700.00	6.75	0.189098	26.46%
	HAZARD INDEX					14278.28	25.51		

ESAP STATIONS - PARCEL C SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-15	alpha-BHC	2	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Aluminum	21500	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Barium	53.4	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Calcium	5260	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Cobalt	24.2	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Dibutyltin	15	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Iron	34400	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Magnesium	12800	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Manganese	554	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Potassium	3710	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Sodium	15800	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Tributyltin	49	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Vanadium	55.6	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Endrin	3	ug/kg	Parcel C	0.02	45	150.00	0.07	89.15%	1.47%
S-15	Arsenic	6.1	mg/kg	Parcel C	8.2	70	0.74	0.09	0.44%	1.93%
S-15	4,4'-DDE	2.7	ug/kg	Parcel C	2.2	27	1.23	0.10	0.73%	2.21%
S-15	Copper	49.4	mg/kg	Parcel C	34	270	1.45	0.18	0.86%	4.05%
S-15	Chromium	78.5	mg/kg	Parcel C	81	370	0.97	0.21	0.58%	4.69%
S-15	Pyrene	700	ug/kg	Parcel C	665	2600	1.05	0.27	0.63%	5.96%
S-15	Zinc	115	mg/kg	Parcel C	150	410	0.77	0.28	0.46%	6.21%
S-15	Mercury	0.35	mg/kg	Parcel C	0.15	0.71	2.33	0.49	1.39%	10.91%
S-15	Lead	271	mg/kg	Parcel C	46.7	218	5.80	1.24	3.45%	27.50%
S-15	Nickel	81.8	mg/kg	Parcel C	20.9	51.6	3.91	1.59	2.33%	35.07%
	HAZARD INDEX						168.26	4.52		

ESAP STATIONS - PARCEL C SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-16	Aluminum	21000	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Barium	51.2	mg/kg	Parcel C	---	---	---	---	---	---
S-16	beta-BHC	1.7	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Calcium	4830	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Cobalt	20.3	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Dibutyltin	13	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Iron	34900	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Magnesium	12800	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Manganese	531	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Potassium	3830	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Sodium	16200	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Tributyltin	51	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Vanadium	55.5	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Endrin	2	ug/kg	Parcel C	0.02	45	100.00	0.04	86.35%	1.11%
S-16	Arsenic	5.1	mg/kg	Parcel C	8.2	70	0.62	0.07	0.54%	1.83%
S-16	4,4'-DDE	3.1	ug/kg	Parcel C	2.2	27	1.41	0.11	1.22%	2.88%
S-16	Copper	51.2	mg/kg	Parcel C	34	270	1.51	0.19	1.30%	4.75%
S-16	Pyrene	500	ug/kg	Parcel C	665	2600	0.75	0.19	0.65%	4.82%
S-16	Chromium	80.7	mg/kg	Parcel C	81	370	1.00	0.22	0.86%	5.46%
S-16	Zinc	141	mg/kg	Parcel C	150	410	0.94	0.34	0.81%	8.62%
S-16	Mercury	0.28	mg/kg	Parcel C	0.15	0.71	1.87	0.39	1.61%	9.88%
S-16	Lead	172	mg/kg	Parcel C	46.7	218	3.68	0.79	3.18%	19.77%
S-16	Nickel	84.2	mg/kg	Parcel C	20.9	51.6	4.03	1.63	3.48%	40.88%
	HAZARD INDEX						115.80	3.99		

ESAP STATIONS - PARCEL C SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-17	alpha-BHC	11	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Aluminum	21900	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Barium	53.5	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Calcium	5090	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Cobalt	14.4	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Dibutyltin	8	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Iron	33500	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Magnesium	12500	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Manganese	576	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Potassium	3760	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Sodium	16100	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Tributyltin	39	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Vanadium	55.8	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Endrin	1.8	ug/kg	Parcel C	0.02	45	90.00	0.04	82.72%	1.15%
S-17	Arsenic	5.6	mg/kg	Parcel C	8.2	70	0.68	0.08	0.63%	2.30%
S-17	Lead	22.8	mg/kg	Parcel C	46.7	218	0.49	0.10	0.45%	3.00%
S-17	4,4'-DDE	3.3	ug/kg	Parcel C	2.2	27	1.50	0.12	1.38%	3.51%
S-17	4,4'-DDD	3.2	ug/kg	Parcel C	2	20	1.60	0.16	1.47%	4.60%
S-17	Copper	46	mg/kg	Parcel C	34	270	1.35	0.17	1.24%	4.89%
S-17	4,4'-DDT	7.9	ug/kg	Parcel C	1.58	46.1	5.00	0.17	4.60%	4.92%
S-17	Chromium	79.6	mg/kg	Parcel C	81	370	0.98	0.22	0.90%	6.18%
S-17	Zinc	118	mg/kg	Parcel C	150	410	0.79	0.29	0.72%	8.27%
S-17	Mercury	0.36	mg/kg	Parcel C	0.15	0.71	2.40	0.51	2.21%	14.57%
S-17	Nickel	83.7	mg/kg	Parcel C	20.9	51.6	4.00	1.62	3.68%	46.60%
	HAZARD INDEX						108.80	3.48		

ESAP STATIONS - PARCEL C 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-15	Acetone	150	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Aluminum	25700	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Aroclor-1260	120	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Barium	61.6	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Calcium	5680	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Cobalt	31	mg/kg	Parcel C	---	---	---	---	---	---
S-15	delta-BHC	4.1	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Dibutyltin	15	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Iron	39700	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Magnesium	14400	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Manganese	511	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Methyl ethyl ketone	39	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Methylene chloride	13	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Potassium	4400	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Sodium	14500	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Toluene	6	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Tributyltin	63	ug/kg	Parcel C	---	---	---	---	---	---
S-15	Vanadium	67.2	mg/kg	Parcel C	---	---	---	---	---	---
S-15	Arsenic	4.5	mg/kg	Parcel C	8.2	70	0.55	0.06	0.08%	0.61%
S-15	Fluoranthene	510	ug/kg	Parcel C	600	5100	0.85	0.10	0.13%	0.95%
S-15	Endrin	6.3	ug/kg	Parcel C	0.02	45	315.00	0.14	48.74%	1.33%
S-15	Lead	39.4	mg/kg	Parcel C	46.7	218	0.84	0.18	0.13%	1.72%
S-15	Copper	63.7	mg/kg	Parcel C	34	270	1.87	0.24	0.29%	2.25%
S-15	Chromium	95.8	mg/kg	Parcel C	81	370	1.18	0.26	0.18%	2.47%
S-15	Pyrene	880	ug/kg	Parcel C	665	2600	1.32	0.34	0.20%	3.22%
S-15	Zinc	147	mg/kg	Parcel C	150	410	0.98	0.36	0.15%	3.42%
S-15	Dieldrin	5.3	ug/kg	Parcel C	0.02	8	265.00	0.66	41.00%	6.31%
S-15	4,4'-DDT	34	ug/kg	Parcel C	1.58	46.1	21.52	0.74	3.33%	7.03%
S-15	4,4'-DDE	22	ug/kg	Parcel C	2.2	27	10.00	0.81	1.55%	7.76%
S-15	Nickel	93.8	mg/kg	Parcel C	20.9	51.6	4.49	1.82	0.69%	17.32%
S-15	Mercury	3.4	mg/kg	Parcel C	0.15	0.71	22.67	4.79	3.51%	45.61%
	HAZARD INDEX						646.28	10.50		

ESAP STATIONS - PARCEL C 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-16	Acetone	210	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Aluminum	29600	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Barium	70.1	mg/kg	Parcel C	---	---	---	---	---	---
S-16	beta-BHC	8.3	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Calcium	5960	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Cobalt	30.9	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Dibutyltin	10	ug/kg	Parcel C	---	---	---	---	---	---
S-16	gamma-Chlordane	4.3	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Heptachlor	1.2	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Iron	44100	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Magnesium	15700	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Manganese	626	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Methylene chloride	15	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Potassium	5070	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Sodium	17700	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Toluene	14	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Tributyltin	24	ug/kg	Parcel C	---	---	---	---	---	---
S-16	Vanadium	78.4	mg/kg	Parcel C	---	---	---	---	---	---
S-16	Arsenic	4.8	mg/kg	Parcel C	8.2	70	0.59	0.07	0.08%	0.95%
S-16	Pyrene	500	ug/kg	Parcel C	665	2600	0.75	0.19	0.10%	2.67%
S-16	Endrin	8.9	ug/kg	Parcel C	0.02	45	445.00	0.20	61.10%	2.74%
S-16	4,4'-DDE	6.3	ug/kg	Parcel C	2.2	27	2.86	0.23	0.39%	3.24%
S-16	4,4'-DDT	11	ug/kg	Parcel C	1.58	46.1	6.96	0.24	0.96%	3.31%
S-16	Copper	65.2	mg/kg	Parcel C	34	270	1.92	0.24	0.26%	3.35%
S-16	Chromium	101	mg/kg	Parcel C	81	370	1.25	0.27	0.17%	3.79%
S-16	Zinc	153	mg/kg	Parcel C	150	410	1.02	0.37	0.14%	5.18%
S-16	Dieldrin	5	ug/kg	Parcel C	0.02	8	250.00	0.63	34.33%	8.67%
S-16	Mercury	0.76	mg/kg	Parcel C	0.15	0.71	5.07	1.07	0.70%	14.85%
S-16	Lead	375	mg/kg	Parcel C	46.7	218	8.03	1.72	1.10%	23.86%
S-16	Nickel	102	mg/kg	Parcel C	20.9	51.6	4.88	1.98	0.67%	27.41%
	HAZARD INDEX						728.32	7.21		

ESAP STATIONS - PARCEL C 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-17	Acetone	130	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Aluminum	25500	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Barium	57.6	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Calcium	4840	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Cobalt	14	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Dibutyltin	7	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Iron	36600	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Magnesium	13200	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Manganese	510	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Methyl ethyl ketone	37	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Methylene chloride	16	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Potassium	4120	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Sodium	14800	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Toluene	10	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Tributyltin	22	ug/kg	Parcel C	---	---	---	---	---	---
S-17	Vanadium	62.3	mg/kg	Parcel C	---	---	---	---	---	---
S-17	Arsenic	4.2	mg/kg	Parcel C	8.2	70	0.51	0.06	0.23%	1.26%
S-17	Endrin	3.9	ug/kg	Parcel C	0.02	45	195.00	0.09	89.41%	1.81%
S-17	Copper	49.6	mg/kg	Parcel C	34	270	1.46	0.18	0.67%	3.84%
S-17	Chromium	83.4	mg/kg	Parcel C	81	370	1.03	0.23	0.47%	4.72%
S-17	4,4'-DDD	5.2	ug/kg	Parcel C	2	20	2.60	0.26	1.19%	5.44%
S-17	Zinc	129	mg/kg	Parcel C	150	410	0.86	0.31	0.39%	6.58%
S-17	Mercury	0.26	mg/kg	Parcel C	0.15	0.71	1.73	0.37	0.79%	7.66%
S-17	4,4'-DDE	11	ug/kg	Parcel C	2.2	27	5.00	0.41	2.29%	8.53%
S-17	Lead	278	mg/kg	Parcel C	46.7	218	5.95	1.28	2.73%	26.69%
S-17	Nickel	82.5	mg/kg	Parcel C	20.9	51.6	3.95	1.60	1.81%	33.46%
	HAZARD INDEX						218.09	4.78		

ESAP STATIONS - PARCEL D SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-05	alpha-BHC	13	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Aluminum	24200	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Barium	57.4	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Calcium	5070	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Dibutyltin	10	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Iron	35500	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Magnesium	12800	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Manganese	595	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Potassium	3920	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Sodium	15800	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Tributyltin	54	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Vanadium	61	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Arsenic	3.7	mg/kg	Parcel D	8.2	70	0.45	0.05	0.19%	1.62%
S-05	Endrin	4.4	ug/kg	Parcel D	0.02	45	220.00	0.10	94.46%	2.99%
S-05	Lead	22.8	mg/kg	Parcel D	46.7	218	0.49	0.10	0.21%	3.20%
S-05	Copper	46.2	mg/kg	Parcel D	34	270	1.36	0.17	0.58%	5.23%
S-05	4,4'-DDE	5.3	ug/kg	Parcel D	2.2	27	2.41	0.20	1.03%	6.00%
S-05	Chromium	85	mg/kg	Parcel D	81	370	1.05	0.23	0.45%	7.02%
S-05	Zinc	134	mg/kg	Parcel D	150	410	0.89	0.33	0.38%	9.99%
S-05	Mercury	0.34	mg/kg	Parcel D	0.15	0.71	2.27	0.48	0.97%	14.64%
S-05	Nickel	83.2	mg/kg	Parcel D	20.9	51.6	3.98	1.61	1.71%	49.30%
	HAZARD INDEX						232.90	3.27		

ESAP STATIONS - PARCEL D SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-06	alpha-BHC	7	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Aluminum	18500	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Aroclor-1260	25	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Barium	47.2	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Benzo(b)fluoranthene	500	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Benzo(g,h,i)perylene	580	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Benzo(k)fluoranthene	490	ug/kg	Parcel D	---	---	---	---	---	---
S-06	beta-BHC	1.2	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Calcium	4420	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Cobalt	10.8	mg/kg	Parcel D	---	---	---	---	---	---
S-06	delta-BHC	2.6	ug/mg	Parcel D	---	---	---	---	---	---
S-06	Dibutyltin	12	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Indeno(1,2,3-cd)pyrene	480	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Iron	30100	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Magnesium	11100	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Manganese	432	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Potassium	3270	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Sodium	12600	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Tributyltin	48	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Vanadium	48.1	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Arsenic	5.6	mg/kg	Parcel D	8.2	70	0.68	0.08	2.23%	1.53%
S-06	4,4'-DDE	2.6	ug/kg	Parcel D	2.2	27	1.18	0.10	3.86%	1.84%
S-06	Lead	23.6	mg/kg	Parcel D	46.7	218	0.51	0.11	1.65%	2.06%
S-06	4,4'-DDD	2.8	ug/kg	Parcel D	2	20	1.40	0.14	4.57%	2.67%
S-06	Fluoranthene	780	ug/kg	Parcel D	600	5100	1.30	0.15	4.25%	2.92%
S-06	Chrysene	450	ug/kg	Parcel D	400	2800	1.13	0.16	3.68%	3.06%
S-06	Copper	43.7	mg/kg	Parcel D	34	270	1.29	0.16	4.20%	3.09%
S-06	Chromium	71.3	mg/kg	Parcel D	81	370	0.88	0.19	2.88%	3.67%
S-06	Zinc	106	mg/kg	Parcel D	150	410	0.71	0.26	2.31%	4.93%
S-06	Benzo(a)pyrene	440	ug/kg	Parcel D	430	1600	1.02	0.28	3.34%	5.24%
S-06	4,4'-DDT	13	ug/kg	Parcel D	1.58	46.1	8.23	0.28	26.88%	5.38%
S-06	Pyrene	980	ug/kg	Parcel D	665	2600	1.47	0.38	4.81%	7.19%
S-06	Nickel	72.8	mg/kg	Parcel D	20.9	51.6	3.48	1.41	11.38%	26.90%
S-06	Mercury	1.1	mg/kg	Parcel D	0.15	0.71	7.33	1.55	23.96%	29.54%
	HAZARD INDEX						30.61	5.25		

ESAP STATIONS - PARCEL D SURFACE SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-07	alpha-BHC	3.5	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Aluminum	14900	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Barium	43.8	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Benzo(b)fluoranthene	320	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Benzo(g,h,i)perylene	440	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Benzo(k)fluoranthene	340	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Calcium	4510	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Cobalt	11.5	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Dibutyltin	9	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Iron	24800	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Magnesium	9480	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Manganese	286	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Potassium	2680	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Sodium	9050	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Tributyltin	54	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Vanadium	39.3	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Endrin	1.7	ug/kg	Parcel D	0.02	45	85.00	0.04	79.72%	0.81%
S-07	Arsenic	3.6	mg/kg	Parcel D	8.2	70	0.44	0.05	0.41%	1.10%
S-07	4,4'-DDE	2.1	ug/kg	Parcel D	2.2	27	0.95	0.08	0.90%	1.66%
S-07	4,4'-DDD	2.4	ug/kg	Parcel D	2	20	1.20	0.12	1.13%	2.56%
S-07	Copper	32.7	mg/kg	Parcel D	34	270	0.96	0.12	0.90%	2.58%
S-07	Chromium	58	mg/kg	Parcel D	81	370	0.72	0.16	0.67%	3.35%
S-07	Chrysene	440	ug/kg	Parcel D	400	2800	1.10	0.16	1.03%	3.35%
S-07	Fluoranthene	880	ug/kg	Parcel D	600	5100	1.47	0.17	1.38%	3.68%
S-07	Benzo(a)anthracene	370	ug/kg	Parcel D	261	1600	1.42	0.23	1.33%	4.93%
S-07	Zinc	110	mg/kg	Parcel D	150	410	0.73	0.27	0.69%	5.73%
S-07	Benzo(a)pyrene	500	ug/kg	Parcel D	430	1600	1.16	0.31	1.09%	6.67%
S-07	Phenanthrene	600	ug/kg	Parcel D	240	1500	2.50	0.40	2.34%	8.54%
S-07	Lead	87.9	mg/kg	Parcel D	46.7	218	1.88	0.40	1.77%	8.60%
S-07	Pyrene	1200	ug/kg	Parcel D	665	2600	1.80	0.46	1.69%	9.85%
S-07	Mercury	0.33	mg/kg	Parcel D	0.15	0.71	2.20	0.46	2.06%	9.92%
S-07	Nickel	64.5	mg/kg	Parcel D	20.9	51.6	3.09	1.25	2.89%	26.67%
	HAZARD INDEX						106.62	4.69		

ESAP STATIONS - PARCEL D 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-05	Acetone	190	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Aluminum	25100	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Barium	55.9	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Calcium	4870	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Cobalt	27.4	mg/kg	Parcel D	---	---	---	---	---	---
S-05	delta-BHC	41	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Dibutyltin	14	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Iron	37400	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Magnesium	13300	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Manganese	456	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Methylene chloride	12	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Potassium	4410	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Sodium	15200	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Toluene	13	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Tributyltin	32	ug/kg	Parcel D	---	---	---	---	---	---
S-05	Vanadium	65.6	mg/kg	Parcel D	---	---	---	---	---	---
S-05	Arsenic	2.5	mg/kg	Parcel D	8.2	70	0.30	0.04	0.11%	0.92%
S-05	Lead	24.9	mg/kg	Parcel D	46.7	218	0.53	0.11	0.18%	2.94%
S-05	Endrin	5.4	ug/kg	Parcel D	0.02	45	270.00	0.12	93.62%	3.09%
S-05	Copper	52.4	mg/kg	Parcel D	34	270	1.54	0.19	0.53%	4.99%
S-05	Chromium	88.7	mg/kg	Parcel D	81	370	1.10	0.24	0.38%	6.16%
S-05	4,4'-DDE	8	ug/kg	Parcel D	2.2	27	3.64	0.30	1.26%	7.62%
S-05	4,4'-DDD	7.7	ug/kg	Parcel D	2	20	3.85	0.39	1.33%	9.90%
S-05	Zinc	172	mg/kg	Parcel D	150	410	1.15	0.42	0.40%	10.79%
S-05	Mercury	0.36	mg/kg	Parcel D	0.15	0.71	2.40	0.51	0.83%	13.04%
S-05	Nickel	81.4	mg/kg	Parcel D	20.9	51.6	3.89	1.58	1.35%	40.56%
	HAZARD INDEX						**288.40**	**3.89**		

ESAP STATIONS - PARCEL D 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-06	Acetone	400	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Aluminum	23100	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Barium	53.9	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Calcium	5030	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Carbon disulfide	26	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Cobalt	17.3	mg/kg	Parcel D	---	---	---	---	---	---
S-06	delta-BHC	8.5	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Dibutyltin	12	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Iron	35100	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Magnesium	12600	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Manganese	456	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Methoxychlor	13	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Methyl ethyl ketone	130	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Methylene chloride	38	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Potassium	4080	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Sodium	13200	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Tributyltin	38	ug/kg	Parcel D	---	---	---	---	---	---
S-06	Vanadium	60.3	mg/kg	Parcel D	---	---	---	---	---	---
S-06	Arsenic	4.1	mg/kg	Parcel D	8.2	70	0.50	0.06	0.21%	1.73%
S-06	Lead	21.5	mg/kg	Parcel D	46.7	218	0.46	0.10	0.19%	2.92%
S-06	Endrin	4.6	ug/kg	Parcel D	0.02	45	230.00	0.10	95.24%	3.03%
S-06	Copper	50.1	mg/kg	Parcel D	34	270	1.47	0.19	0.61%	5.50%
S-06	Pyrene	490	ug/kg	Parcel D	665	2600	0.74	0.19	0.31%	5.58%
S-06	Chromium	84.6	mg/kg	Parcel D	81	370	1.04	0.23	0.43%	6.77%
S-06	Zinc	143	mg/kg	Parcel D	150	410	0.95	0.35	0.39%	10.33%
S-06	Mercury	0.31	mg/kg	Parcel D	0.15	0.71	2.07	0.44	0.86%	12.93%
S-06	Nickel	89.2	mg/kg	Parcel D	20.9	51.6	4.27	1.73	1.77%	51.20%
	HAZARD INDEX						**241.50**	**3.38**		

ESAP STATIONS - PARCEL D 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-07	Acetone	81	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Aluminum	18500	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Barium	45.5	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Benzo(g,h,i)perylene	360	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Calcium	4090	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Cobalt	12.9	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Dibutyltin	10	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Iron	30500	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Magnesium	11300	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Manganese	312	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Methyl ethyl ketone	23	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Methylene chloride	6	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Potassium	3520	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Sodium	10700	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Toluene	6	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Tributyltin	48	ug/kg	Parcel D	---	---	---	---	---	---
S-07	Vanadium	48.9	mg/kg	Parcel D	---	---	---	---	---	---
S-07	Arsenic	2.9	mg/kg	Parcel D	8.2	70	0.35	0.04	0.24%	0.90%
S-07	Endrin	2.4	ug/kg	Parcel D	0.02	45	120.00	0.05	82.42%	1.16%
S-07	Fluoranthene	580	ug/kg	Parcel D	600	5100	0.97	0.11	0.66%	2.47%
S-07	4,4'-DDE	4.4	ug/kg	Parcel D	2.2	27	2.00	0.16	1.37%	3.54%
S-07	Copper	44.5	mg/kg	Parcel D	34	270	1.31	0.16	0.90%	3.58%
S-07	4,4'-DDT	7.6	ug/kg	Parcel D	1.58	46.1	4.81	0.16	3.30%	3.58%
S-07	Chromium	73.3	mg/kg	Parcel D	81	370	0.90	0.20	0.62%	4.30%
S-07	Benzo(a)pyrene	400	ug/kg	Parcel D	430	1600	0.93	0.25	0.64%	5.43%
S-07	Zinc	103	mg/kg	Parcel D	150	410	0.69	0.25	0.47%	5.46%
S-07	Phenanthrene	380	ug/kg	Parcel D	240	1500	1.58	0.25	1.09%	5.50%
S-07	4,4'-DDD	5.6	ug/kg	Parcel D	2	20	2.80	0.28	1.92%	6.08%
S-07	Pyrene	810	ug/kg	Parcel D	665	2600	1.22	0.31	0.84%	6.77%
S-07	Mercury	0.25	mg/kg	Parcel D	0.15	0.71	1.67	0.35	1.14%	7.65%
S-07	Lead	140	mg/kg	Parcel D	46.7	218	3.00	0.64	2.06%	13.95%
S-07	Nickel	70.4	mg/kg	Parcel D	20.9	51.6	3.37	1.36	2.31%	29.63%
	HAZARD INDEX						145.60	4.60		

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-08	Aluminum	16800	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Barium	45.1	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Benzo(b)fluoranthene	440	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Benzo(g,h,i)perylene	590	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Benzo(k)fluoranthene	530	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Calcium	4400	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Cobalt	13.6	mg/kg	Parcel E	---	---	---	---	---	---
S-08	delta-BHC	1.8	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Dibutyltin	10	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Indeno(1,2,3-cd)pyrene	480	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Iron	28700	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Magnesium	10900	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Manganese	382	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Potassium	3130	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Sodium	11000	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Tributyltin	40	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Vanadium	47.4	mg/kg	Parcel E	---	---	---	---	---	---
S-08	4,4'-DDE	2	ug/kg	Parcel E	2.2	27	0.91	0.07	3.98%	1.51%
S-08	Arsenic	5.5	mg/kg	Parcel E	8.2	70	0.67	0.08	2.93%	1.60%
S-08	Lead	20.8	mg/kg	Parcel E	46.7	218	0.45	0.10	1.95%	1.95%
S-08	4,4'-DDD	2.2	ug/kg	Parcel E	2	20	1.10	0.11	4.81%	2.25%
S-08	Copper	37.7	mg/kg	Parcel E	34	270	1.11	0.14	4.85%	2.85%
S-08	Chromium	70.6	mg/kg	Parcel E	81	370	0.87	0.19	3.81%	3.90%
S-08	Fluoranthene	1100	ug/kg	Parcel E	600	5100	1.83	0.22	8.02%	4.40%
S-08	Chrysene	620	ug/kg	Parcel E	400	2800	1.55	0.22	6.78%	4.52%
S-08	Zinc	97.3	mg/kg	Parcel E	150	410	0.65	0.24	2.84%	4.85%
S-08	Mercury	0.23	mg/kg	Parcel E	0.15	0.71	1.53	0.32	6.71%	6.61%
S-08	Benzo(a)anthracene	530	ug/kg	Parcel E	261	1600	2.03	0.33	8.88%	6.76%
S-08	Phenanthrene	660	ug/kg	Parcel E	240	1500	2.75	0.44	12.03%	8.98%
S-08	Benzo(a)pyrene	710	ug/kg	Parcel E	430	1600	1.65	0.44	7.22%	9.06%
S-08	Pyrene	1500	ug/kg	Parcel E	665	2600	2.26	0.58	9.87%	11.78%
S-08	Nickel	73.2	mg/kg	Parcel E	20.9	51.6	3.50	1.42	15.32%	28.97%
	HAZARD INDEX						22.86	4.90		

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-09	alpha-BHC	2.2	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Aluminum	9050	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Aroclor-1260	75	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Barium	19.7	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Calcium	59600	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Cobalt	8.9	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Dibutyltin	2	ug/kg	Parcel E	---	---	---	---	---	---
S-09	gamma-BHC	4.4	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Iron	16200	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Magnesium	7170	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Manganese	404	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Methoxychlor	14	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Potassium	1690	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Sodium	6000	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Tributyltin	6	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Vanadium	26.6	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Arsenic	4	mg/kg	Parcel E	8.2	70	0.49	0.06	0.09%	2.26%
S-09	Lead	15.3	mg/kg	Parcel E	46.7	218	0.33	0.07	0.06%	2.78%
S-09	Copper	21.6	mg/kg	Parcel E	34	270	0.64	0.08	0.12%	3.17%
S-09	Endrin	4.1	ug/kg	Parcel E	0.02	45	205.00	0.09	39.83%	3.60%
S-09	4,4'-DDT	4.4	ug/kg	Parcel E	1.58	46.1	2.78	0.10	0.54%	3.78%
S-09	4,4'-DDD	2	ug/kg	Parcel E	2	20	1.00	0.10	0.19%	3.96%
S-09	4,4'-DDE	3.5	ug/kg	Parcel E	2.2	27	1.59	0.13	0.31%	5.13%
S-09	Chromium	50	mg/kg	Parcel E	81	370	0.62	0.14	0.12%	5.35%
S-09	Zinc	60.5	mg/kg	Parcel E	150	410	0.40	0.15	0.08%	5.84%
S-09	Dieldrin	6	ug/kg	Parcel E	0.02	8	300.00	0.75	58.29%	29.68%
S-09	Nickel	47.9	mg/kg	Parcel E	20.9	51.6	2.29	0.93	0.45%	36.73%
	HAZARD INDEX						514.65	2.53		

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-10	Aldrin	6.1	ug/kg	Parcel E	---	---	---	---	---	---
S-10	alpha-BHC	3.3	ug/kg	Parcel E	---	---	---	---	---	---
S-10	alpha-Chlordane	1.8	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Aluminum	21100	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Aroclor-1260	100	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Barium	53.6	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Beryllium	1.2	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Calcium	10700	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Cobalt	23.6	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Dibutyltin	10	ug/kg	Parcel E	---	---	---	---	---	---
S-10	gamma-Chlordane	0.9	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Iron	35800	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Magnesium	13200	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Manganese	535	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Methoxychlor	41	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Potassium	3470	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Sodium	11100	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Tributyltin	20	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Vanadium	64.6	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Arsenic	3.8	mg/kg	Parcel E	8.2	70	0.46	0.05	0.08%	1.07%
S-10	Endrin	4.5	ug/kg	Parcel E	0.02	45	225.00	0.10	38.02%	1.97%
S-10	Fluoranthene	530	ug/kg	Parcel E	600	5100	0.88	0.10	0.15%	2.05%
S-10	4,4'-DDE	3.5	ug/kg	Parcel E	2.2	27	1.59	0.13	0.27%	2.56%
S-10	Lead	28.4	mg/kg	Parcel E	46.7	218	0.61	0.13	0.10%	2.57%
S-10	4,4'-DDT	7.3	ug/kg	Parcel E	1.58	46.1	4.62	0.16	0.78%	3.12%
S-10	4,4'-DDD	3.7	ug/kg	Parcel E	2	20	1.85	0.19	0.31%	3.65%
S-10	Copper	51.7	mg/kg	Parcel E	34	270	1.52	0.19	0.26%	3.78%
S-10	Benzo(a)pyrene	330	ug/kg	Parcel E	430	1600	0.77	0.21	0.13%	4.07%
S-10	Chromium	95.8	mg/kg	Parcel E	81	370	1.18	0.26	0.20%	5.11%
S-10	Pyrene	710	ug/kg	Parcel E	665	2600	1.07	0.27	0.18%	5.39%
S-10	Zinc	119	mg/kg	Parcel E	150	410	0.79	0.29	0.13%	5.73%
S-10	Mercury	0.37	mg/kg	Parcel E	0.15	0.71	2.47	0.52	0.42%	10.28%
S-10	Dieldrin	6.9	ug/kg	Parcel E	0.02	8	345.00	0.86	58.30%	17.01%
S-10	Nickel	82.8	mg/kg	Parcel E	20.9	51.6	3.96	1.60	0.67%	31.65%
	HAZARD INDEX						591.78	5.07		

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-11	alpha-BHC	3.9	ug/kg	Parcel E	---	---	---	---	---	---
S-11	alpha-Chlordane	3.7	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Aluminum	18500	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Aroclor-1260	240	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Barium	58.6	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Calcium	19100	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Cobalt	20.2	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Dibutyltin	13	ug/kg	Parcel E	---	---	---	---	---	---
S-11	gamma-BHC	4.7	ug/kg	Parcel E	---	---	---	---	---	---
S-11	gamma-Chlordane	1.1	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Iron	35600	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Magnesium	15300	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Manganese	437	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Potassium	3260	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Sodium	13400	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Tributyltin	27	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Vanadium	56.9	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Arsenic	5	mg/kg	Parcel E	8.2	70	0.61	0.07	0.08%	1.96%
S-11	Lead	35	mg/kg	Parcel E	46.7	218	0.75	0.16	0.09%	4.41%
S-11	4,4'-DDT	8.1	ug/kg	Parcel E	1.58	46.1	5.13	0.18	0.64%	4.83%
S-11	4,4'-DDE	5.1	ug/kg	Parcel E	2.2	27	2.32	0.19	0.29%	5.19%
S-11	Endrin	8.5	ug/kg	Parcel E	0.02	45	425.00	0.19	52.84%	5.19%
S-11	4,4'-DDD	4.1	ug/kg	Parcel E	2	20	2.05	0.21	0.25%	5.63%
S-11	Copper	64.1	mg/kg	Parcel E	34	270	1.89	0.24	0.23%	6.52%
S-11	Chromium	98.9	mg/kg	Parcel E	81	370	1.22	0.27	0.15%	7.35%
S-11	Zinc	123	mg/kg	Parcel E	150	410	0.82	0.30	0.10%	8.24%
S-11	Dieldrin	7.2	ug/kg	Parcel E	0.02	8	360.00	0.90	44.76%	24.73%
S-11	Mercury	0.67	mg/kg	Parcel E	0.15	0.71	4.47	0.94	0.56%	25.93%
S-11	Nickel	101	mg/kg	Parcel E	20.9	51.6	4.83	1.96	0.60%	53.79%
	HAZARD INDEX						804.25	3.64		

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-12	alpha-BHC	9.2	ug/kg	Parcel E	---	---	---	---	---	---
S-12	alpha-Chlordane	7.7	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Aluminum	20300	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Aroclor-1260	740	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Barium	65.7	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Bis(2-ethylhexyl)phthalate	480	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Calcium	6810	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Cobalt	19.3	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Dibutyltin	44	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Endosulfan I	17	ug/kg	Parcel E	---	---	---	---	---	---
S-12	gamma-Chlordane	4.5	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Iron	34600	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Magnesium	14400	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Manganese	358	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Potassium	3830	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Sodium	13800	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Tributyltin	78	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Vanadium	60.7	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Arsenic	4	mg/kg	Parcel E	8.2	70	0.49	0.06	0.07%	0.71%
S-12	Pyrene	410	ug/kg	Parcel E	665	2600	0.62	0.16	0.09%	1.96%
S-12	4,4'-DDT	11	ug/kg	Parcel E	1.58	46.1	6.96	0.24	1.01%	2.97%
S-12	Copper	83.8	mg/kg	Parcel E	34	270	2.46	0.31	0.36%	3.87%
S-12	Chromium	126	mg/kg	Parcel E	81	370	1.56	0.34	0.23%	4.24%
S-12	4,4'-DDE	11	ug/kg	Parcel E	2.2	27	5.00	0.41	0.72%	5.07%
S-12	Zinc	181	mg/kg	Parcel E	150	410	1.21	0.44	0.17%	5.50%
S-12	Lead	116	mg/kg	Parcel E	46.7	218	2.48	0.53	0.36%	6.63%
S-12	Mercury	0.62	mg/kg	Parcel E	0.15	0.71	4.13	0.87	0.60%	10.88%
S-12	4,4'-DDD	21	ug/kg	Parcel E	2	20	10.50	1.05	1.52%	13.08%
S-12	Dieldrin	13	ug/kg	Parcel E	0.02	8	650.00	1.63	94.16%	20.24%
S-12	Nickel	103	mg/kg	Parcel E	20.9	51.6	4.93	2.00	0.71%	24.86%
	HAZARD INDEX						690.34	8.03		

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-14	alpha-BHC	8.6	ug/kg	Parcel E	---	---	---	---	---	---
S-14	alpha-Chlordane	7.6	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Aluminum	23900	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Aroclor-1260	300	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Barium	71.9	mg/kg	Parcel E	---	---	---	---	---	---
S-14	beta-BHC	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Bis(2-ethylhexyl)phthalate	660	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Calcium	5020	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Cobalt	21.1	mg/kg	Parcel E	---	---	---	---	---	---
S-14	delta-BHC	6.2	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Dibutyltin	25	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Endosulfan I	11	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Endosulfan II	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Endosulfan sulfate	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Endrin ketone	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	gamma-BHC	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	gamma-Chlordane	4.4	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Heptachlor	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Heptachlor epoxide	0.48	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Hexachlorobenzene	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Hexachlorobutadiene	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Hexachlorocyclopentadiene	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Hexachloroethane	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Indeno(1,2,3-cd)pyrene	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Iron	37400	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Isophorone	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Magnesium	13800	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Manganese	353	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Methoxychlor	3.6	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Molybdenum	7.4	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Monobutyltin	2.5	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Nitrobenzene	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	n-Nitrosodiphenylamine	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	n-Nitrosodipropylamine	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Pentachlorophenol	8500	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Phenol	1700	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Potassium	4550	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Sodium	16000	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Tetrabutyltin	2.5	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Toxaphene	11	ug/kg	Parcel E	---	---	---	---	---	---

ESAP STATIONS - PARCEL E SURFACE SEDIMENT

Station	Chemcal	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
S-14	Tributyltin	35	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Vanadium	66.6	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Arsenic	3.6	mg/kg	Parcel E	8.2	70	0.44	0.05	0.04%	0.38%
S-14	Pyrene	470	ug/kg	Parcel E	665	2600	0.71	0.18	0.06%	1.35%
S-14	4,4'-DDT	8.6	ug/kg	Parcel E	1.58	46.1	5.44	0.19	0.46%	1.39%
S-14	Endrin	11	ug/kg	Parcel E	0.02	45	550.00	0.24	46.07%	1.83%
S-14	4,4'-DDE	8.1	ug/kg	Parcel E	2.2	27	3.68	0.30	0.31%	2.24%
S-14	Copper	82.4	mg/kg	Parcel E	34	270	2.42	0.31	0.20%	2.28%
S-14	Chromium	114	mg/kg	Parcel E	81	370	1.41	0.31	0.12%	2.30%
S-14	4,4'-DDD	6.2	ug/kg	Parcel E	2	20	3.10	0.31	0.26%	2.32%
S-14	Fluoranthene	1700	ug/kg	Parcel E	600	5100	2.83	0.33	0.24%	2.49%
S-14	Zinc	179	mg/kg	Parcel E	150	410	1.19	0.44	0.10%	3.26%
S-14	Mercury	0.43	mg/kg	Parcel E	0.15	0.71	2.87	0.61	0.24%	4.53%
S-14	Lead	134	mg/kg	Parcel E	46.7	218	2.87	0.61	0.24%	4.59%
S-14	Naphthalene	1700	ug/kg	Parcel E	160	2100	10.63	0.81	0.89%	6.05%
S-14	Phenanthrene	1700	ug/kg	Parcel E	240	1500	7.08	1.13	0.59%	8.47%
S-14	Dieldrin	10	ug/kg	Parcel E	0.02	8	500.00	1.25	41.89%	9.34%
S-14	Silver	5.3	mg/kg	Parcel E	1	3.7	5.30	1.43	0.44%	10.70%
S-14	Nickel	89.4	mg/kg	Parcel E	20.9	51.6	4.28	1.73	0.36%	12.95%
S-14	Fluorene	1700	ug/kg	Parcel E	19	540	89.47	3.15	7.50%	23.52%
	HAZARD INDEX						1193.72	13.38		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-08	Acetone	300	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Aluminum	22400	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Barium	59.5	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Beryllium	1.3	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Calcium	4720	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Carbon disulfide	16	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Cobalt	12.8	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Dibutyltin	16	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Endosulfan I	1.7	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Iron	35000	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Magnesium	12500	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Manganese	485	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Methyl ethyl ketone	62	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Methylene chloride	9	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Potassium	4230	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Sodium	12600	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Toluene	15	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Tributyltin	36	ug/kg	Parcel E	---	---	---	---	---	---
S-08	Vanadium	55.9	mg/kg	Parcel E	---	---	---	---	---	---
S-08	Arsenic	4.7	mg/kg	Parcel E	8.2	70	0.57	0.07	0.28%	1.68%
S-08	Fluoranthene	410	ug/kg	Parcel E	600	5100	0.68	0.08	0.33%	2.01%
S-08	Endrin	3.7	ug/kg	Parcel E	0.02	45	185.00	0.08	89.51%	2.06%
S-08	Lead	33.8	mg/kg	Parcel E	46.7	218	0.72	0.16	0.35%	3.88%
S-08	4,4'-DDD	3.2	ug/kg	Parcel E	2	20	1.60	0.16	0.77%	4.00%
S-08	4,4'-DDT	7.8	ug/kg	Parcel E	1.58	46.1	4.94	0.17	2.39%	4.23%
S-08	Copper	51.1	mg/kg	Parcel E	34	270	1.50	0.19	0.73%	4.74%
S-08	Chromium	79.7	mg/kg	Parcel E	81	370	0.98	0.22	0.48%	5.39%
S-08	Pyrene	600	ug/kg	Parcel E	665	2600	0.90	0.23	0.44%	5.78%
S-08	4,4'-DDE	6.3	ug/kg	Parcel E	2.2	27	2.86	0.23	1.39%	5.84%
S-08	Mercury	0.27	mg/kg	Parcel E	0.15	0.71	1.80	0.38	0.87%	9.52%
S-08	Zinc	158	mg/kg	Parcel E	150	410	1.05	0.39	0.51%	9.64%
S-08	Nickel	85	mg/kg	Parcel E	20.9	51.6	4.07	1.65	1.97%	41.23%
	HAZARD INDEX						206.69	4.00		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-09	Acetone	83	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Aluminum	26900	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Aroclor-1260	160	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Barium	66.6	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Beryllium	1.3	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Calcium	5510	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Cobalt	18.1	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Dibutyltin	8	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Iron	39900	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Magnesium	14000	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Manganese	363	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Potassium	4740	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Sodium	12200	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Tributyltin	6	ug/kg	Parcel E	---	---	---	---	---	---
S-09	Vanadium	72.9	mg/kg	Parcel E	---	---	---	---	---	---
S-09	Arsenic	3.4	mg/kg	Parcel E	8.2	70	0.41	0.05	0.03%	0.95%
S-09	Copper	62.7	mg/kg	Parcel E	34	270	1.84	0.23	0.15%	4.52%
S-09	Chromium	130	mg/kg	Parcel E	81	370	1.60	0.35	0.13%	6.85%
S-09	Zinc	166	mg/kg	Parcel E	150	410	1.11	0.40	0.09%	7.89%
S-09	Lead	116	mg/kg	Parcel E	46.7	218	2.48	0.53	0.20%	10.37%
S-09	Endrin	24	ug/kg	Parcel E	0.02	45	1200.00	0.53	97.37%	10.39%
S-09	Mercury	0.41	mg/kg	Parcel E	0.15	0.71	2.73	0.58	0.22%	11.25%
S-09	4,4'-DDT	28	ug/kg	Parcel E	1.58	46.1	17.72	0.61	1.44%	11.83%
S-09	Nickel	95.2	mg/kg	Parcel E	20.9	51.6	4.56	1.84	0.37%	35.95%
	HAZARD INDEX						1232.46	5.13		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-10	Acetone	110	ug/kg	Parcel E	---	---	---	---	---	---
S-10	alpha-BHC	3	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Aluminum	22400	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Barium	52.7	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Beryllium	0.84	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Calcium	5170	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Carbon disulfide	14	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Cobalt	18.9	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Iron	33400	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Magnesium	11000	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Manganese	276	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Methoxychlor	36	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Methyl ethyl ketone	22	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Methylene chloride	19	ug/kg	Parcel E	---	---	---	---	---	---
S-10	Potassium	3840	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Sodium	12700	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Vanadium	66	mg/kg	Parcel E	---	---	---	---	---	---
S-10	Lead	10.2	mg/kg	Parcel E	46.7	218	0.22	0.05	0.17%	1.91%
S-10	Endrin	2.3	ug/kg	Parcel E	0.02	45	115.00	0.05	92.09%	2.09%
S-10	Copper	37.7	mg/kg	Parcel E	34	270	1.11	0.14	0.89%	5.71%
S-10	4,4'-DDE	4.4	ug/kg	Parcel E	2.2	27	2.00	0.16	1.60%	6.66%
S-10	Zinc	74.5	mg/kg	Parcel E	150	410	0.50	0.18	0.40%	7.43%
S-10	Chromium	75.9	mg/kg	Parcel E	81	370	0.94	0.21	0.75%	8.39%
S-10	Mercury	0.32	mg/kg	Parcel E	0.15	0.71	2.13	0.45	1.71%	18.43%
S-10	Nickel	62.3	mg/kg	Parcel E	20.9	51.6	2.98	1.21	2.39%	49.37%
	HAZARD INDEX						124.88	2.45		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-11	Acetone	50	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Aluminum	24800	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Barium	42.1	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Beryllium	0.99	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Calcium	6080	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Carbon disulfide	21	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Cobalt	23.3	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Dibutyltin	7	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Iron	42600	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Magnesium	14300	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Manganese	439	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Methylene chloride	11	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Potassium	4390	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Sodium	9280	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Tributyltin	16	ug/kg	Parcel E	---	---	---	---	---	---
S-11	Vanadium	68.5	mg/kg	Parcel E	---	---	---	---	---	---
S-11	Arsenic	7.4	mg/kg	Parcel E	8.2	70	0.90	0.11	10.01%	4.03%
S-11	Copper	40.6	mg/kg	Parcel E	34	270	1.19	0.15	13.25%	5.73%
S-11	Zinc	87.5	mg/kg	Parcel E	150	410	0.58	0.21	6.47%	8.14%
S-11	Chromium	84	mg/kg	Parcel E	81	370	1.04	0.23	11.51%	8.66%
S-11	Mercury	0.17	mg/kg	Parcel E	0.15	0.71	1.13	0.24	12.57%	9.13%
S-11	Nickel	87	mg/kg	Parcel E	20.9	51.6	4.16	1.69	46.19%	64.30%
	HAZARD INDEX						9.01	2.62		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-12	Acetone	93	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Aluminum	25100	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Aroclor-1260	40	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Barium	70.5	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Beryllium	1.4	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Calcium	23300	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Carbon disulfide	36	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Cobalt	17.8	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Dibutyltin	2	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Iron	38600	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Magnesium	14900	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Manganese	357	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Methoxychlor	16	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Methyl ethyl ketone	28	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Methylene chloride	15	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Potassium	4770	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Sodium	12700	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Toluene	6	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Tributyltin	4	ug/kg	Parcel E	---	---	---	---	---	---
S-12	Vanadium	71.8	mg/kg	Parcel E	---	---	---	---	---	---
S-12	Endrin	4	ug/kg	Parcel E	0.02	45	200.00	0.09	40.06%	1.46%
S-12	4,4'-DDT	4.5	ug/kg	Parcel E	1.58	46.1	2.85	0.10	0.57%	1.61%
S-12	4,4'-DDE	3.2	ug/kg	Parcel E	2.2	27	1.45	0.12	0.29%	1.95%
S-12	4,4'-DDD	3	ug/kg	Parcel E	2	20	1.50	0.15	0.30%	2.47%
S-12	Pyrene	420	ug/kg	Parcel E	665	2600	0.63	0.16	0.13%	2.66%
S-12	Copper	75.9	mg/kg	Parcel E	34	270	2.23	0.28	0.45%	4.63%
S-12	Zinc	201	mg/kg	Parcel E	150	410	1.34	0.49	0.27%	8.08%
S-12	Lead	113	mg/kg	Parcel E	46.7	218	2.42	0.52	0.48%	8.54%
S-12	Chromium	207	mg/kg	Parcel E	81	370	2.56	0.56	0.51%	9.22%
S-12	Dieldrin	5.5	ug/kg	Parcel E	0.02	8	275.00	0.69	55.09%	11.33%
S-12	Mercury	0.64	mg/kg	Parcel E	0.15	0.71	4.27	0.90	0.85%	14.85%
S-12	Nickel	104	mg/kg	Parcel E	20.9	51.6	4.98	2.02	1.00%	33.20%
	HAZARD INDEX						499.22	6.07		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-13	Acetone	220	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Aldrin	1900	ug/kg	Parcel E	---	---	---	---	---	---
S-13	alpha-BHC	49	ug/kg	Parcel E	---	---	---	---	---	---
S-13	alpha-Chlordane	15	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Aluminum	26100	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Barium	130	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Benzo(g,h,i)perylene	530	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Bis(2-ethylhexyl)phthalate	890	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Calcium	5810	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Carbon disulfide	43	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Cobalt	17.6	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Dibutyltin	12	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Endosulfan I	25	ug/kg	Parcel E	---	---	---	---	---	---
S-13	gamma-Chlordane	24	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Iron	40300	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Magnesium	14700	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Manganese	325	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Methyl ethyl ketone	54	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Methylene chloride	25	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Potassium	5140	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Sodium	15200	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Toluene	12	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Tributyltin	10	ug/kg	Parcel E	---	---	---	---	---	---
S-13	Vanadium	75.2	mg/kg	Parcel E	---	---	---	---	---	---
S-13	Arsenic	3.5	mg/kg	Parcel E	8.2	70	0.43	0.05	0.01%	0.19%
S-13	Fluoranthene	830	ug/kg	Parcel E	600	5100	1.38	0.16	0.03%	0.63%
S-13	Chrysene	680	ug/kg	Parcel E	400	2800	1.70	0.24	0.03%	0.95%
S-13	Benzo(a)pyrene	500	ug/kg	Parcel E	430	1600	1.16	0.31	0.02%	1.22%
S-13	Pyrene	1300	ug/kg	Parcel E	665	2600	1.95	0.50	0.04%	1.95%
S-13	Copper	138	mg/kg	Parcel E	34	270	4.06	0.51	0.07%	1.99%
S-13	Endrin	39	ug/kg	Parcel E	0.02	45	1950.00	0.87	35.95%	3.38%
S-13	Lead	248	mg/kg	Parcel E	46.7	218	5.31	1.14	0.10%	4.43%
S-13	Zinc	477	mg/kg	Parcel E	150	410	3.18	1.16	0.06%	4.53%
S-13	4,4'-DDD	28	ug/kg	Parcel E	2	20	14.00	1.40	0.26%	5.45%
S-13	Mercury	1	mg/kg	Parcel E	0.15	0.71	6.67	1.41	0.12%	5.49%
S-13	Chromium	575	mg/kg	Parcel E	81	370	7.10	1.55	0.13%	6.06%
S-13	Nickel	106	mg/kg	Parcel E	20.9	51.6	5.07	2.05	0.09%	8.00%
S-13	4,4'-DDE	160	ug/kg	Parcel E	2.2	27	72.73	5.93	1.34%	23.09%

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-13	Dieldrin	67	ug/kg	Parcel E	0.02	8	3350.00	8.38	61.75%	32.63%
	HAZARD INDEX						**5424.74**	**25.66**		

ESAP STATIONS - PARCEL E 2.5 FEET SEDIMENT

Station	Chemical	Value	Units	Parcel	ER-L	ER-M	HQ-L	HQ-M	%H-L	%H-M
S-14	Acetone	120	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Aluminum	23800	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Aroclor-1260	170	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Barium	72.3	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Benzo(b)fluoranthene	510	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Benzo(g,h,i)perylene	390	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Benzo(k)fluoranthene	450	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Calcium	9160	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Carbon disulfide	16	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Cobalt	27.2	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Dibutyltin	11	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Indeno(1,2,3-cd)pyrene	470	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Iron	38800	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Magnesium	15100	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Manganese	343	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Methylene chloride	8	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Potassium	4750	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Sodium	13500	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Toluene	13	ug/kg	Parcel E	---	---	---	---	---	---
S-14	Vanadium	68.3	mg/kg	Parcel E	---	---	---	---	---	---
S-14	Fluoranthene	420	ug/kg	Parcel E	600	5100	0.70	0.08	0.06%	1.09%
S-14	Arsenic	7.3	mg/kg	Parcel E	8.2	70	0.89	0.10	0.08%	1.37%
S-14	Endrin	7.8	ug/kg	Parcel E	0.02	45	390.00	0.17	36.21%	2.29%
S-14	4,4'-DDD	5.7	ug/kg	Parcel E	2	20	2.85	0.29	0.26%	3.76%
S-14	Copper	78	mg/kg	Parcel E	34	270	2.29	0.29	0.21%	3.81%
S-14	Pyrene	910	ug/kg	Parcel E	665	2600	1.37	0.35	0.13%	4.61%
S-14	4,4'-DDE	10	ug/kg	Parcel E	2.2	27	4.55	0.37	0.42%	4.88%
S-14	Benzo(a)pyrene	610	ug/kg	Parcel E	430	1600	1.42	0.38	0.13%	5.03%
S-14	4,4'-DDT	18	ug/kg	Parcel E	1.58	46.1	11.39	0.39	1.06%	5.15%
S-14	Chromium	155	mg/kg	Parcel E	81	370	1.91	0.42	0.18%	5.52%
S-14	Zinc	230	mg/kg	Parcel E	150	410	1.53	0.56	0.14%	7.40%
S-14	Mercury	0.56	mg/kg	Parcel E	0.15	0.71	3.73	0.79	0.35%	10.40%
S-14	Dieldrin	13	ug/kg	Parcel E	0.02	8	650.00	1.63	60.35%	21.42%
S-14	Nickel	91.1	mg/kg	Parcel E	20.9	51.6	4.36	1.77	0.40%	23.28%
	HAZARD INDEX						1077.00	7.59		

IR01 INTERTIDAL SEDIMENTS

STATION	CHEMICAL	VALUE	UNITS	PARCEL	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
IR01	Naphthalene	59.67	ug/kg	Parcel E	160	2100	0.37	0.03	0.10%	0.08%
IR01	Arsenic	4.95	mg/kg	Parcel E	8.2	70	0.60	0.07	0.17%	0.19%
IR01	4,4'-DDE	2.93	ug/kg	Parcel E	2.2	27	1.33	0.11	0.37%	0.30%
IR01	4,4'-DDD	2.45	ug/kg	Parcel E	2	20	1.23	0.12	0.34%	0.34%
IR01	Silver	0.59	mg/kg	Parcel E	1	3.7	0.59	0.16	0.17%	0.44%
IR01	Acenaphthylene	142	ug/kg	Parcel E	44	640	3.23	0.22	0.91%	0.61%
IR01	Chromium	91.67	mg/kg	Parcel E	81	370	1.13	0.25	0.32%	0.68%
IR01	Cadmium	2.68	ug/mg	Parcel E	1.2	9.6	2.23	0.28	0.63%	0.77%
IR01	2-Methylnaphthalene	190	ug/kg	Parcel E	70	670	2.71	0.28	0.76%	0.78%
IR01	4,4'-DDT	26	ug/kg	Parcel E	1.58	46.1	16.46	0.56	4.62%	1.55%
IR01	Mercury	0.54	mg/kg	Parcel E	0.15	0.71	3.60	0.76	1.01%	2.09%
IR01	Benzo(a)pyrene	1566.57	ug/mg	Parcel E	430	1600	3.64	0.98	1.02%	2.69%
IR01	Zinc	403.27	mg/kg	Parcel E	150	410	2.69	0.98	0.75%	2.71%
IR01	Fluoranthene	5364	ug/kg	Parcel E	600	5100	8.94	1.05	2.51%	2.89%
IR01	Copper	335.25	mg/kg	Parcel E	34	270	9.86	1.24	2.77%	3.42%
IR01	Chrysene	4061.14	ug/mg	Parcel E	400	2800	10.15	1.45	2.85%	3.99%
IR01	Benzo(a)anthracene	2456.29	ug/mg	Parcel E	261	1600	9.41	1.54	2.64%	4.22%
IR01	Phenanthrene	2385.33	ug/kg	Parcel E	240	1500	9.94	1.59	2.79%	4.37%
IR01	Pyrene	4263.78	ug/kg	Parcel E	665	2600	6.41	1.64	1.80%	4.51%
IR01	Dibenzo(a,h)anthracene	430.33	ug/mg	Parcel E	63.4	260	6.79	1.66	1.91%	4.55%
IR01	Nickel	100.94	mg/kg	Parcel E	20.9	51.6	4.83	1.96	1.36%	5.38%
IR01	Fluorene	1183.33	ug/kg	Parcel E	19	540	62.28	2.19	17.49%	6.03%
IR01	Acenaphthene	1200	ug/kg	Parcel E	16	500	75.00	2.40	21.06%	6.60%
IR01	Anthracene	5816.5	ug/mg	Parcel E	85.3	1100	68.19	5.29	19.15%	14.55%
IR01	Lead	2080.25	mg/kg	Parcel E	46.7	218	44.54	9.54	12.51%	26.25%
	HAZARD INDEX						356.16	36.35		

IR02 INTERTIDAL SEDIMENTS

STATION	CHEMICAL	VALUE	UNITS	PARCEL	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
IR02	Fluoranthene	187.78	ug/kg	Parcel E	600	5100	0.31	0.04	0.17%	0.16%
IR02	Anthracene	49	ug/mg	Parcel E	85.3	1100	0.57	0.04	0.32%	0.19%
IR02	Pyrene	138.56	ug/kg	Parcel E	665	2600	0.21	0.05	0.11%	0.23%
IR02	Benzo(a)pyrene	90	ug/mg	Parcel E	430	1600	0.21	0.06	0.12%	0.24%
IR02	Chrysene	175.71	ug/mg	Parcel E	400	2800	0.44	0.06	0.24%	0.27%
IR02	Benzo(a)anthracene	121.75	ug/mg	Parcel E	261	1600	0.47	0.08	0.26%	0.32%
IR02	Naphthalene	163.33	ug/kg	Parcel E	160	2100	1.02	0.08	0.56%	0.33%
IR02	Arsenic	6.67	mg/kg	Parcel E	8.2	70	0.81	0.10	0.45%	0.40%
IR02	Phenanthrene	144.13	ug/kg	Parcel E	240	1500	0.60	0.10	0.33%	0.41%
IR02	Chromium	149.63	mg/kg	Parcel E	81	370	1.85	0.40	1.02%	1.71%
IR02	Cadmium	5.54	ug/mg	Parcel E	1.2	9.6	4.62	0.58	2.54%	2.44%
IR02	Copper	220.54	mg/kg	Parcel E	34	270	6.49	0.82	3.57%	3.46%
IR02	Mercury	0.58	mg/kg	Parcel E	0.15	0.71	3.87	0.82	2.13%	3.46%
IR02	Zinc	519.74	mg/kg	Parcel E	150	410	3.46	1.27	1.90%	5.37%
IR02	4,4'-DDE	48	ug/kg	Parcel E	2.2	27	21.82	1.78	11.99%	7.53%
IR02	4,4'-DDT	93	ug/kg	Parcel E	1.58	46.1	58.86	2.02	32.35%	8.55%
IR02	Nickel	150.33	mg/kg	Parcel E	20.9	51.6	7.19	2.91	3.95%	12.34%
IR02	4,4'-DDD	62	ug/kg	Parcel E	2	20	31.00	3.10	17.04%	13.13%
IR02	Lead	823.27	mg/kg	Parcel E	46.7	218	17.63	3.78	9.69%	16.00%
IR02	Silver	20.5	mg/kg	Parcel E	1	3.7	20.50	5.54	11.27%	23.47%
	HAZARD INDEX						181.93	23.61		

IR03 INTERTIDAL SAMPLES

STATION	CHEMICAL	VALUE	UNITS	PARCEL	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
IR03	Chrysene	92	ug/mg	Parcel E	400	2800	0.23	0.03	0.76%	0.42%
IR03	Fluoranthene	205	ug/kg	Parcel E	600	5100	0.34	0.04	1.13%	0.52%
IR03	Benzo(a)pyrene	65	ug/mg	Parcel E	430	1600	0.15	0.04	0.50%	0.52%
IR03	Pyrene	107	ug/kg	Parcel E	665	2600	0.16	0.04	0.53%	0.53%
IR03	Benzo(a)anthracene	71	ug/mg	Parcel E	261	1600	0.27	0.04	0.90%	0.57%
IR03	Arsenic	4.1	mg/kg	Parcel E	8.2	70	0.50	0.06	1.66%	0.75%
IR03	Phenanthrene	96	ug/kg	Parcel E	240	1500	0.40	0.06	1.32%	0.82%
IR03	Lead	39.5	mg/kg	Parcel E	46.7	218	0.85	0.18	2.80%	2.32%
IR03	Chromium	87	mg/kg	Parcel E	81	370	1.07	0.24	3.56%	3.02%
IR03	Copper	75	mg/kg	Parcel E	34	270	2.21	0.28	7.30%	3.56%
IR03	Cadmium	2.7	ug/mg	Parcel E	1.2	9.6	2.25	0.28	7.45%	3.61%
IR03	Mercury	0.22	mg/kg	Parcel E	0.15	0.71	1.47	0.31	4.86%	3.97%
IR03	Zinc	161.01	mg/kg	Parcel E	150	410	1.07	0.39	3.55%	5.04%
IR03	Nickel	92.71	mg/kg	Parcel E	20.9	51.6	4.44	1.80	14.68%	23.05%
IR03	Silver	14.8	mg/kg	Parcel E	1	3.7	14.80	4.00	48.99%	51.31%
	HAZARD INDEX						30.21	7.80		

IR07 INTERTIDAL SAMPLES

STATION	CHEMICAL	VALUE	UNITS	PARCEL	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
IR07	Arsenic	4.33	mg/kg	Parcel B	8.2	70	0.53	0.06	0.96%	0.37%
IR07	Cadmium	0.73	ug/mg	Parcel B	1.2	9.6	0.61	0.08	1.11%	0.46%
IR07	Chrysene	341.69	ug/mg	Parcel B	400	2800	0.85	0.12	1.55%	0.73%
IR07	Fluoranthene	694.74	ug/kg	Parcel B	600	5100	1.16	0.14	2.11%	0.82%
IR07	Pyrene	606.8	ug/kg	Parcel B	665	2600	0.91	0.23	1.66%	1.41%
IR07	Phenanthrene	816.57	ug/kg	Parcel B	240	1500	3.40	0.54	6.19%	3.28%
IR07	Mercury	0.4	mg/kg	Parcel B	0.15	0.71	2.67	0.56	4.85%	3.39%
IR07	Copper	154.4	mg/kg	Parcel B	34	270	4.54	0.57	8.26%	3.44%
IR07	Chromium	313.21	mg/kg	Parcel B	81	370	3.87	0.85	7.03%	5.10%
IR07	Zinc	362.67	mg/kg	Parcel B	150	410	2.42	0.88	4.40%	5.33%
IR07	Lead	298.4	mg/kg	Parcel B	46.7	218	6.39	1.37	11.62%	8.24%
IR07	Nickel	577.7	mg/kg	Parcel B	20.9	51.6	27.64	11.20	50.27%	67.42%
	HAZARD INDEX						54.99	16.60		

REFERENCE STATIONS - SURFACE SAMPLES

Station	Chemcal	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
RS-1	Aluminum	18900	mg/kg	---	---	---	---	---	---
RS-1	Iron	30200	mg/kg	---	---	---	---	---	---
RS-1	Vanadium	52.9	mg/kg	---	---	---	---	---	---
RS-1	Barium	44.8	mg/kg	---	---	---	---	---	---
RS-1	Potassium	3300	mg/kg	---	---	---	---	---	---
RS-1	Manganese	262	mg/kg	---	---	---	---	---	---
RS-1	Magnesium	11000	mg/kg	---	---	---	---	---	---
RS-1	Sodium	11100	mg/kg	---	---	---	---	---	---
RS-1	Indeno(1,2,3-cd)pyrene	1600	ug/kg	---	---	---	---	---	---
RS-1	Cobalt	16.4	mg/kg	---	---	---	---	---	---
RS-1	Calcium	10400	mg/kg	---	---	---	---	---	---
RS-1	Benzo(k)fluoranthene	1200	ug/kg	---	---	---	---	---	---
RS-1	Benzo(g,h,i)perylene	2100	ug/kg	---	---	---	---	---	---
RS-1	Benzo(b)fluoranthene	1400	ug/kg	---	---	---	---	---	---
RS-1	Endrin	2	ug/kg	0.02	45	100.00	0.04	73.89%	0.59%
RS-1	4,4'-DDE	1.9	ug/kg	2.2	27	0.86	0.07	0.64%	0.93%
RS-1	Arsenic	5.1	mg/kg	8.2	70	0.62	0.07	0.46%	0.97%
RS-1	Copper	45.5	mg/kg	34	270	1.34	0.17	0.99%	2.23%
RS-1	Chromium	71.2	mg/kg	81	370	0.88	0.19	0.65%	2.55%
RS-1	Zinc	93.5	mg/kg	150	410	0.62	0.23	0.46%	3.02%
RS-1	Fluoranthene	2300	ug/kg	600	5100	3.83	0.45	2.83%	5.98%
RS-1	Chrysene	1300	ug/kg	400	2800	3.25	0.46	2.40%	6.15%
RS-1	Phenanthrene	890	ug/kg	240	1500	3.71	0.59	2.74%	7.86%
RS-1	Mercury	0.44	mg/kg	0.15	0.71	2.93	0.62	2.17%	8.21%
RS-1	Benzo(a)anthracene	1000	ug/kg	261	1600	3.83	0.63	2.83%	8.28%
RS-1	Pyrene	3400	ug/kg	665	2600	5.11	1.31	3.78%	17.33%
RS-1	Benzo(a)pyrene	2100	ug/kg	430	1600	4.88	1.31	3.61%	17.39%
RS-1	Nickel	72.1	mg/kg	20.9	51.6	3.45	1.40	2.55%	18.51%
	HAZARD INDEX					135.33	7.55		

REFERENCE STATIONS - SURFACE SAMPLES

Station	Chemcal	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
RS-2	Aluminum	23000	mg/kg	---	---	---	---	---	---
RS-2	Barium	53.1	mg/kg	---	---	---	---	---	---
RS-2	Calcium	4420	mg/kg	---	---	---	---	---	---
RS-2	Cobalt	23.1	mg/kg	---	---	---	---	---	---
RS-2	Iron	35800	mg/kg	---	---	---	---	---	---
RS-2	Magnesium	13000	mg/kg	---	---	---	---	---	---
RS-2	Manganese	315	mg/kg	---	---	---	---	---	---
RS-2	Potassium	4210	mg/kg	---	---	---	---	---	---
RS-2	Sodium	14700	mg/kg	---	---	---	---	---	---
RS-2	Tributyltin	18	ug/kg	---	---	---	---	---	---
RS-2	Vanadium	61.3	mg/kg	---	---	---	---	---	---
RS-2	Endrin	5.1	ug/kg	0.02	45	255.00	0.11	93.26%	2.56%
RS-2	4,4'-DDD	2.7	ug/kg	2	20	1.35	0.14	0.49%	3.05%
RS-2	4,4'-DDE	5.1	ug/kg	2.2	27	2.32	0.19	0.85%	4.26%
RS-2	Copper	51	mg/kg	34	270	1.50	0.19	0.55%	4.26%
RS-2	Chromium	86.6	mg/kg	81	370	1.07	0.23	0.39%	5.28%
RS-2	Zinc	119	mg/kg	150	410	0.79	0.29	0.29%	6.55%
RS-2	Lead	326	mg/kg	46.7	218	6.98	1.50	2.55%	33.75%
RS-2	Nickel	92.1	mg/kg	20.9	51.6	4.41	1.78	1.61%	40.28%
	HAZARD INDEX					**273.42**	**4.43**		

REFERENCE STATIONS - SURFACE SAMPLES

Station	Chemcal	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
RS-3	Aluminum	23500	mg/kg	---	---	---	---	---	---
RS-3	Barium	55.9	mg/kg	---	---	---	---	---	---
RS-3	Calcium	4430	mg/kg	---	---	---	---	---	---
RS-3	Cobalt	23.8	mg/kg	---	---	---	---	---	---
RS-3	Iron	32400	mg/kg	---	---	---	---	---	---
RS-3	Magnesium	9970	mg/kg	---	---	---	---	---	---
RS-3	Manganese	417	mg/kg	---	---	---	---	---	---
RS-3	Potassium	3200	mg/kg	---	---	---	---	---	---
RS-3	Sodium	11200	mg/kg	---	---	---	---	---	---
RS-3	Vanadium	67.8	mg/kg	---	---	---	---	---	---
RS-3	Arsenic	6.8	mg/kg	8.2	70	0.83	0.10	4.69%	2.23%
RS-3	Chromium	70.5	mg/kg	81	370	0.87	0.19	4.92%	4.37%
RS-3	Copper	55.6	mg/kg	34	270	1.64	0.21	9.25%	4.72%
RS-3	Zinc	123	mg/kg	150	410	0.82	0.30	4.64%	6.88%
RS-3	Mercury	0.48	mg/kg	0.15	0.71	3.20	0.68	18.10%	15.51%
RS-3	Nickel	74.3	mg/kg	20.9	51.6	3.56	1.44	20.11%	33.03%
RS-3	Lead	316	mg/kg	46.7	218	6.77	1.45	38.28%	33.25%
	HAZARD INDEX					17.68	4.36		

REFERENCE STATIONS - 2.5 FEET SAMPLES

Station	Chemcal	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
RS-1	Aluminum	17500	mg/kg	---	---	---	---	---	---
RS-1	Barium	35.2	mg/kg	---	---	---	---	---	---
RS-1	Calcium	7820	mg/kg	---	---	---	---	---	---
RS-1	Cobalt	19.8	mg/kg	---	---	---	---	---	---
RS-1	Iron	27200	mg/kg	---	---	---	---	---	---
RS-1	Magnesium	9700	mg/kg	---	---	---	---	---	---
RS-1	Manganese	261	mg/kg	---	---	---	---	---	---
RS-1	Potassium	3460	mg/kg	---	---	---	---	---	---
RS-1	Sodium	10600	mg/kg	---	---	---	---	---	---
RS-1	Vanadium	47.7	mg/kg	---	---	---	---	---	---
RS-1	Arsenic	7.2	mg/kg	8.2	70	0.88	0.10	6.04%	4.65%
RS-1	Copper	28.1	mg/kg	34	270	0.83	0.10	5.68%	4.71%
RS-1	Chromium	56.7	mg/kg	81	370	0.70	0.15	4.81%	6.93%
RS-1	Zinc	62.9	mg/kg	150	410	0.42	0.15	2.88%	6.94%
RS-1	Mercury	0.18	mg/kg	0.15	0.71	1.20	0.25	8.25%	11.46%
RS-1	4,4'-DDT	12	ug/kg	1.58	46.1	7.59	0.26	52.23%	11.77%
RS-1	Nickel	61.1	mg/kg	20.9	51.6	2.92	1.18	20.10%	53.54%
	HAZARD INDEX					14.54	2.21		

REFERENCE STATIONS - 2.5 FEET SAMPLES

Station	Chemcal	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-L	%HI-M
RS-2	Aluminum	22000	mg/kg	---	---	---	---	---	---
RS-2	Barium	50.8	mg/kg	---	---	---	---	---	---
RS-2	Calcium	4130	mg/kg	---	---	---	---	---	---
RS-2	Cobalt	26.6	mg/kg	---	---	---	---	---	---
RS-2	Iron	35200	mg/kg	---	---	---	---	---	---
RS-2	Magnesium	12800	mg/kg	---	---	---	---	---	---
RS-2	Manganese	310	mg/kg	---	---	---	---	---	---
RS-2	Potassium	4080	mg/kg	---	---	---	---	---	---
RS-2	Sodium	14100	mg/kg	---	---	---	---	---	---
RS-2	Tributyltin	15	ug/kg	---	---	---	---	---	---
RS-2	Vanadium	57	mg/kg	---	---	---	---	---	---
RS-2	Arsenic	2.9	mg/kg	8.2	70	0.35	0.04	0.16%	0.83%
RS-2	Endrin	2.2	ug/kg	0.02	45	110.00	0.05	48.73%	0.97%
RS-2	4,4'-DDE	3	ug/kg	2.2	27	1.36	0.11	0.60%	2.22%
RS-2	Copper	49.4	mg/kg	34	270	1.45	0.18	0.64%	3.65%
RS-2	4,4'-DDD	4.2	ug/kg	2	20	2.10	0.21	0.93%	4.19%
RS-2	Chromium	82.4	mg/kg	81	370	1.02	0.22	0.45%	4.44%
RS-2	Dieldrin	1.9	ug/kg	0.02	8	95.00	0.24	42.09%	4.73%
RS-2	Mercury	0.23	mg/kg	0.15	0.71	1.53	0.32	0.68%	6.46%
RS-2	Zinc	139	mg/kg	150	410	0.93	0.34	0.41%	6.76%
RS-2	Nickel	80.5	mg/kg	20.9	51.6	3.85	1.56	1.71%	31.10%
RS-2	Lead	379	mg/kg	46.7	218	8.12	1.74	3.60%	34.66%
	HAZARD INDEX					225.71	5.02		

REFERENCE STATIONS - 2.5 FEET SAMPLES

Station	Chemcal	Value	Units	ER-L	ER-M	HQ-L	HQ-M	%HI-I	%HI-M
RS-3	Aluminum	2700	mg/kg	---	---	---	---	---	---
RS-3	Barium	62.2	mg/kg	---	---	---	---	---	---
RS-3	Calcium	3590	mg/kg	---	---	---	---	---	---
RS-3	Cobalt	31.4	mg/kg	---	---	---	---	---	---
RS-3	Iron	40300	mg/kg	---	---	---	---	---	---
RS-3	Magnesium	12200	mg/kg	---	---	---	---	---	---
RS-3	Manganese	644	mg/kg	---	---	---	---	---	---
RS-3	Potassium	3810	mg/kg	---	---	---	---	---	---
RS-3	Sodium	11800	mg/kg	---	---	---	---	---	---
RS-3	Vanadium	76.9	mg/kg	---	---	---	---	---	---
RS-3	Fluoranthene	580	ug/kg	600	5100	0.97	0.11	5.73%	2.63%
RS-3	Arsenic	13.1	mg/kg	8.2	70	1.60	0.19	9.46%	4.32%
RS-3	Chromium	81.8	mg/kg	81	370	1.01	0.22	5.98%	5.10%
RS-3	Copper	72.8	mg/kg	34	270	2.14	0.27	12.68%	6.22%
RS-3	Benzo(a)pyrene	610	ug/kg	430	1600	1.42	0.38	8.40%	8.80%
RS-3	Zinc	162	mg/kg	150	410	1.08	0.40	6.40%	9.12%
RS-3	Pyrene	1200	ug/kg	665	2600	1.80	0.46	10.69%	10.66%
RS-3	Mercury	0.37	mg/kg	0.15	0.71	2.47	0.52	14.61%	12.03%
RS-3	Nickel	91.9	mg/kg	20.9	51.6	4.40	1.78	26.05%	41.12%
	HAZARD INDEX					16.88	4.33		